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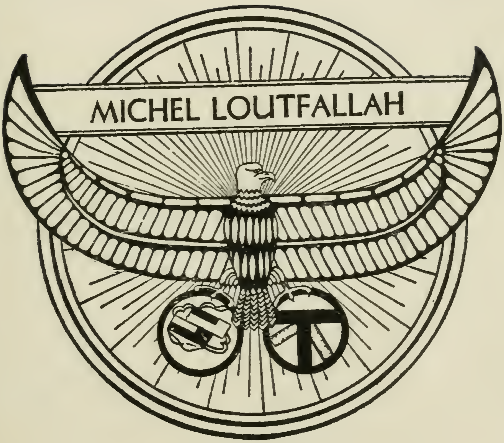
MICHEL LOUTFALLAH

ATLAS AND EPITOME

OF

OPERATIVE OPHTHALMOLOGY

BY

PROF. DR. O. HAAB

of Zurich

AUTHORIZED TRANSLATION FROM THE GERMAN
WITH EDITORIAL NOTES AND ADDITIONS

EDITED BY

G. E. DE SCHWEINITZ, A.M., M.D.

Professor of Ophthalmology in the University of Pennsylvania;
Ophthalmic Surgeon to the Philadelphia Hospital;
Ophthalmologist to the Orthopedic Hospital
and Infirmary for Nervous Diseases

With 30 Colored Lithographic Plates and 154 Text-cuts

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EDITOR'S PREFACE.

This volume forms a natural and admirable conclusion of the series of Atlases which Professor Haab has prepared and published. Beginning with a thorough discussion of the proper construction of operation-rooms, narcosis both general and local, sterilization as it is applied to ophthalmic instruments, and the theory and practice of disinfection, the main operations upon the eye and its appendages are described with characteristic fidelity and clearness. The thirty colored lithographic plates portray in a far more satisfactory way than words can the steps of an operation. Next to seeing an operation itself, these are of value, and in most instances give a view of lifelike accuracy. What is omitted in the colored plates is supplied in the text illustrations, of which there are one hundred and fifty.

As in the previous volumes of this series, one is impressed with Dr. Haab's wide experience, admirable technic, and sound judgment. The editor, as in the previous books of this series, has compared the translation with the original, and believes that it conveys with faithfulness the author's meaning. Editorial comments are

placed in brackets, and a few operations not described by Professor Haab have been inserted.

This book should prove useful not only to students of ophthalmology who may not have the opportunity of witnessing frequently operations upon the eye, but also to those whose daily work is concerned with the operative side of ophthalmic work.

JANUARY, 1905.

PREFACE.

The great abundance of material made it necessary to exercise a certain selection in this Atlas and Epitome of Operative Ophthalmology. I was guided in my selection chiefly by my own practical experience, which covers a period of almost thirty years; but let me say at once that I am not familiar with all the methods of operations described in this work from personal experience with them. In the case of most of them, however, I have determined their advantages by testing them myself. In doing so I found out that it is not only necessary, but also most interesting, for the operator to resort from time to time to other methods besides those on which he was, so to speak, brought up, and which have become a part of him.

I have, therefore, endeavored in this work to describe the various operative interventions in such a way as to enable my colleagues to vary their operative procedures as I myself have done.

As a rule, mere verbal description does not suffice to give a clear idea of operative procedures, and pictorial illustration is therefore indispensable in this kind of work; for which reason a copiously illustrated Atlas is most desirable.

The text, which has been condensed until it contains only what is indispensable, is intended as a guide to students, practitioners, and ophthalmologists in the technic of operations on the eye and their various modifications; and I imagine that assistants who have to prepare an operation will welcome the book because it enables them, without loss of time, to get a general idea of the plan of an operation and the instruments necessary for its performance.

In order to demonstrate the usefulness of a special method of operation I have thought it advisable to give the pictures of cases after recovery. On the other hand, I have omitted many geometric drawings of plastic operations which usually embellish the chapter on Blepharoplastic Operations in most of the current works and textbooks, but which are more likely to have seen the light of day at the desk than on the operating-table, and are therefore of questionable usefulness, especially since the introduction of Thiersch's method of skin-grafting has made so many changes in this branch of surgery.

The illustrations of the instruments in this work were obtained by reproducing the photographs made under my direction by Messrs. H. and E. Butcher, of Zurich, after reducing them one-tenth; except in two groups, those for Krönlein's operation, for which, on account of the size of the instruments, a reduction of one-half was found to be necessary. The instruments which are here represented were obtained in the course of years from the following

firms: Weiss & Son, 287 Oxford street, London, W.; H. Windler, Friedrichstrasse 133 a, Berlin; H. Wulfing-Lüer, 6 Rue Antoine-Dubois, Paris; G. Tiemann & Co., New York; and Chambers, Inskeep & Co., Chicago; but I do not pretend to say that other instrument-makers do not also furnish very good instruments of the kind.

I am indebted to the artist, Mr. J. Fink, for the preparation of the remaining pictures, many of which presented considerable difficulties.

I am also indebted to the publisher, Mr. Lehmann, for his efforts in connection with the preparation of this Atlas.

O. HAAB.

LIST OF LITHOGRAPHIC PLATES.

CONTENTS.

OPERATIVE OPHTHALMOLOGY.

GENERAL CONSIDERATIONS.

SINCE upon the success of an ophthalmic operation, especially an operation for cataract or glaucoma, depends not only the sight of the affected eye, but also that of its fellow, because any operation in which the globe is opened may be followed by sympathetic disease of the other eye—for these considerations an operation on the organ of sight is fraught with great responsibility and should not be lightly undertaken. For most people blindness is as bad as death, and for many it is even worse. As an operation on the eye may often be exceedingly difficult and call for the greatest care and skill on the part of the operator, I fully agree with Snellen when he says: "Although it is true that the operative field in ophthalmology is limited and most of the operations are not formidable, it is nevertheless a mistake to regard operative ophthalmology merely as a part of minor surgery and within the scope of every practitioner, as there appears to be a tendency to do from time to time. When an operation on the eye fails to realize the patient's hopes, the effect is often more tragic than death itself."

In operations on the eye a surgeon must be cool, deliberate, and experienced, or an accident is very likely to happen to him or, rather, to his patient. He must also have well-drilled assistants of the right kind. The most important operations on the eye, particularly those for cataract and glaucoma, are peculiar in that they must be performed in a short space of time; and if the

operator has made a slight mistake, as, for example, in the size or position of his incision, it is often difficult for him to rectify it. Besides, the surgeon is very much dependent on the patient's behavior, which frequently spoils the most beautifully planned operation. In such cases nothing but promptness on the part of the operator to do the right thing and the greatest presence of mind will avert disaster. At the same time the entire operative field must be kept constantly in mind during the entire operation—not only the spot where he happens to be busy with his instruments. It may be asserted with confidence and with entire honesty that an ophthalmic surgeon, be he ever so experienced, never is certain when he begins an uncomplicated operation for cataract how it will end. This feature lends a special character to this operation, which is one of the most important that can be performed on the human subject.

Not only the operation itself, but the after-treatment, the subsequent course, and the question of recovery are very much influenced by the patient's behavior. In the same way the nursing and medical treatment which he receives are important features in bringing about the ultimate result.

Hospital Wards and Operating Rooms.

The question of efficient nursing and treatment is much simplified if the operating room and the wards in which the patients spend their convalescence are properly arranged. By exercising great care and deliberation in the treatment of the eye, from the time of operation until recovery, excellent results may be achieved even under unfavorable external conditions in hospitals and operating rooms which fail to come up to the most modern requirements. Of course, the man who can give his patients the benefit of the scrupulous cleanliness of a modern hospital will have an easier conscience during the operation, and, on the average, more satisfactory results afterward, pro-

vided the nurses and assistants are thoroughly imbued with the principles of modern hospital nursing and the modern treatment of wounds and act according to these principles. The condition of the walls and of the floors has no special bearing in ophthalmic surgery; but the hands of the nurses who take care of the patients are of the utmost importance. For that reason I should like to mention—aside from the well-known architectural advances of the last decades, which ought to be found in every hospital—the fitting up of every room with running hot water as a chief requisite or at least a great advantage for an eye dispensary of any considerable patronage. If hot water and soap are readily accessible, the attendants will have no objection to cleansing their hands at frequent intervals, and this alone is of value.

It has also been found desirable in our clinic at the University, which has now been in operation seven years, to have two rooms adjoining the operating room for patients that have just undergone operation, especially for cataract, one for males and the other for females. The patient's bed is rolled into the operating room, the operation performed while he is in bed, and he is then taken back to his room, so that there is no necessity of lifting him from his bed to the operating table, and from the latter back to his bed. I have no doubt that patients who have been operated upon for cataract or glaucoma may be allowed to walk about and go to their rooms, as is the custom in some hospitals, without any great danger of harm arising therefrom; but it is perfectly evident that complete rest in a recumbent posture immediately after the operation is not only more agreeable to the patient, but also better for the wound, and that in any large hospital it is more convenient simply to transfer the patient in his bed from the operating room to the ward or private room. Since it is of the greatest importance in the case of all wounds that involve division of the capsule of the globe to get primary union, if possible, during the first twenty-four hours after operation,

complete rest during the first day is desirable. The patient himself will realize the importance of such precaution better if the rest begins immediately after the operation and he is not allowed to walk about for a time before he begins his rest in bed. In my private clinic cataract extraction and iridectomy are invariably performed in the patient's own room, and subsequently the latter remains quietly in his bed. This was also the practice of my esteemed master, Horner, both in his clinic and private work. It is possible that this practice is in part responsible for the fact, which has always been a source of personal gratification, that during the twenty-seven years of operative experience (including the time when I was an assistant to Horner) I have had but 1 case—two years ago—of that frightful intra-ocular hemorrhage, which so treacherously destroys the eye immediately or soon after cataract operations.

[An operating chair or table, the height or inclination of which can be altered to suit conditions, and the immediate surroundings of which can be maintained in surgical cleanliness, is preferred by the majority of surgeons. From it the patient can be lifted readily to the bed he afterward occupies without deleterious effort on his part. —Ed.]

It is not necessary to darken the room of a patient recently operated upon. All that is necessary is to arrange the shutters so as to bar out any glaring light that would be equally unpleasant to the normal eye. It is important, however, to see that the ventilation in the rooms is adequate, because the patients are often old and their respiration is insufficient, so that oxygenation and metabolism are incompletely performed.

The enforced rest during the first period should be made more bearable to a patient who has been through an operation for cataract or glaucoma by giving him an electric bell to hold in his hand; in this way we may guard against fright, which in many cases is, perhaps, the precursor of post-operative delirium, especially when

both eyes are bandaged. It is possible my habit of impressing my patients with the advantage of the bell, as Horner was in the habit of doing, is responsible for the fact that this complication (aside from delirium tremens) has so far never occurred in my practice. It has the additional advantage of making it very much easier for the patient to remain strictly quiet during the first twenty-four hours after the operation. If a patient becomes excited, in spite of the fact that both eyes are bandaged, the bandage must be removed from the other eye and, in the case of one-eyed persons, from the operated eye also, a wire screen being applied for protection.

In the arrangement and illumination of the operating room the same rules are to be observed as for operating rooms in general. It is a debatable point whether the color of the walls should be as bright as possible, in accordance with modern ideas on hospital arrangements, or dark ; because in the latter case the amount of lateral illumination is diminished and the operator thus secures a light that is free from reflexes and more agreeable to the eye, as well as better adapted for certain ophthalmic operations. Snellen, after a number of experiments and years of experience, recommends for the walls, floor, and ceiling a dark, dull-black background enlivened with a dark-gray pattern, for the purpose of making a more agreeable impression (a point which I consider of some importance). The north window in the room Snellen has provided with four parallel shades, by means of which the entire window or only a part of it can be darkened. I have also tested this point by way of experiment and operated in a room with black walls, which was generally used for ophthalmoscopy. It is not to be denied that any operations in which the corneal reflex is an important factor and which require the operator's fullest visual acuity such an illumination of the operative field is most desirable and at the same time grateful to the eyes, both of the operator and of

the patient. To be consistent, however, the assistants and other attendants must either wear black gowns or choose their positions so that their white gowns will not reflect the light.

But as we also have to perform operations in which a good light from all directions—such as surgeons prefer in their operating rooms—is desirable; that is to say, operations on the adnexæ of the globe, especially plastic operations, extirpation of the lachrymal sac, Krönlein's operation, etc., it is wiser to steer a middle course and arrange the operating room somewhat in the fashion that I have adopted. The walls should be a light gray, not entirely white; the floor a gray terrazo, and the ceiling white. There should be a large double window, provided with two wooden roller-shades attached outside of the window, by means of which it may be rapidly darkened more or less to suit the exigencies of the moment. Since the amount of light that enters through the window is diminished, the brightness of the walls also diminishes; while at the same time sufficient light falls on the patient and, if the patient's bed is moved sufficiently close to the window, enough light will fall on the eye from the side.

With regard to the proper exposure for the operating room, I find a western light, which circumstances happen to make the only one available, very satisfactory, because, like all my colleagues, I nearly always operate in the forenoon. In cloudy weather this gives a better light than if the room faced the north. [In many American hospitals operations are performed late in the afternoon, hence western light would often not be satisfactory. Practically, however, the lighting by daylight of ophthalmic operating rooms is unimportant if they are provided, as all should be, with suitable stationary as well as portable electric lights, and with shades for darkening the windows, as may be needed.—Ed.]

Another expedient that I have resorted to for years and which, I believe, is also employed in many other clinics and eye hospitals, is to perform operations which require

an especially good light and as accurate vision as possible exclusively with electric illumination to the total exclusion of daylight; this also enables one to control the position of the corneal reflex and to keep everything dark except the small operative field, so as to obtain a maximum visual acuity on the part of the operator and a maximum of light on the operative field. The small incandescent lamp surrounded by a metal tube concentrates its light, which passes through a strong convex lens on a small, clearly and intensely illuminated spot, and, as the lamp is provided with a suitable handle and receives its current from a portable accumulator, the light is thrown on the operative field in such a way as to obviate any disturbance by the corneal reflex. The attendant who looks after the light must, however, pay special attention to one point: the lamp unfortunately soon becomes hot, and if he brings it in contact with the patient's face, as the nose, for instance, he may suddenly start and thus endanger the success of the operation. In some instances it is therefore better to have the lamp fastened to the forehead, as practised and recommended by Czermak. It is not desirable to be without artificial illumination in secondary operations for cataract and other difficult cataract performances. To provide against the accidental failure of the electric light, I use a gas or petroleum lamp and a large convex lens to concentrate the light on the operative field, as I did many years ago, before electricity came into use.

Suitable illumination is so very necessary in many operations on the eye, and particularly in the most important ones, that the operator must never neglect it under any circumstances. In support of this fact, only one example will be mentioned. It not infrequently happens in operations for cataract that, immediately after the capsule of the lens has been opened, a considerable quantity of soft, cortical material from the cataract escapes through the incision. In these cases the compact nucleus of the cataract is small, and does not present so readily in the wound as a large nucleus when the attempt is made to deliver it.

It may even rotate about its transverse axis, and in the attempt to force the delivery by carrying a suitable instrument (scoop) from below over the cornea, with a certain amount of pressure, it not infrequently happens that the nucleus slips by the wound and lodges against the upper ciliary body. If the operator fails to notice this unfavorable position of the nucleus and continues the delivery of the cataract, the nucleus slips on into the upper part of the vitreous, and can not be brought out again even with the aid of a wire loop, the operation is a failure, and the trouble can not be very easily remedied even by a secondary operation. On the other hand, if the operator notices in time this tendency on the part of the nucleus to slip behind the wound—and to do so requires good vision—he can correct it by pushing the nucleus down again with the knife (fleam), and as soon as the upper edge is exactly behind the wound, he can effect the delivery by exerting pressure on the cornea.

In regard to the operating table, it is important that it should be possible to lower the head and raise the foot rapidly, because, in my experience, this is one of the most important procedures when there is trouble with the anesthetization. In other respects the table may be constructed in any way that suits the operator's convenience. It should be made entirely of iron and without any upholstering, both for the sake of convenience and to save time in cleansing it. This feature, however, is immaterial so far as the healing of the operative wound is concerned, and sensitive patients find these hard tables, which so much resemble a machine, both physically and psychically, most unpleasant—another reason why I frequently operate on a patient in bed, but I shall never perform an operation under general anesthesia in bed, unless under very exceptional circumstances. [So many operating tables and operating chairs are now manufactured, adapted to all the exigencies of ophthalmic surgery, that operations performed on the patient's bed, except

when done in private houses, would not seem to many surgeons commendable.—Ed.]

Anesthetization.

My experience with this important subject is that the ophthalmic surgeon will do well to restrict himself as much as possible in the use of general anesthesia with chloroform, ether, bromethyl, or ethyl chlorid. These anesthetics are all dangerous, whatever may be their names, and especially chloroform and ether, the latter perhaps a little less so than the former. [See editorial note on page 28.—Ed.] Chloroform particularly may in certain individuals cause death with lightning rapidity, even at the very beginning of narcosis, and there is no way of recognizing the danger beforehand. As Laqueur recently pointed out in connection with a case of death from chloroform anesthesia, persons with a large thymus gland are particularly predisposed, and it is well known that such persons may die suddenly from other causes, which in some cases are quite trivial, such as a fall into cold water, or even in the absence of any recognizable cause. Unfortunately, enlargement of the thymus gland can not be diagnosed with certainty; but Laqueur points out that the same individuals often present hyperplasia of the lymphatic apparatus in the pharynx from enlargement of the follicles at the base of the tongue and of the tonsils. The presence of such enlargements has a more serious bearing on anesthetization even than a valvular heart-lesion.

Another feature that renders anesthetization more dangerous in operations on the eye, so that a normal patient is in constant danger, even when narcosis is properly carried out, is the fact that the eye is so slow to lose its sensibility. [The eye may be anesthetized with cocain.—Ed.] The general surgeon can operate on the trunk and extremities long before the ophthalmic surgeon may begin to cut—if he really wishes to operate under total and not

under partial anesthesia. For that reason many ophthalmic surgeons operate under partial anesthesia, although they may not be quite conscious of the fact. In my experience even etherization is not without danger if carried to the point of actual, profound anesthesia. I have witnessed the most dangerous collapse from ether in the case of two women: One of them had a moderate goiter and was menstruating at the time of the operation; in the other I could not find any reason for the accident, which almost ended fatally. In both, the pulse and the breathing became worse and worse during the operation, and the most vigorous measures for resuscitation were repeatedly employed to avert a fatal issue. I have repeatedly seen similar grave accidents from cardiac weakness in chloroform anesthesia. In several cases of chloroform and ether anesthesia cardiac weakness did not develop until after the anesthetization was completed and the patient had partially regained consciousness; the attendants were compelled to continue their efforts at resuscitation for from one-half to one hour. For this reason I always have the pulse and respiration carefully watched after the operation when a patient has had a general anesthetic.

Furthermore, in cases of enucleation I avoid cutting the optic and ciliary nerves while the patient is in profound anesthesia, and prefer not to take this final step until the patient begins to show some reaction. For frequently severe collapse has occurred, evidently brought on by the shock which immediately followed the snip of the scissors.

In reviving a patient who has gone into collapse I have found it useful: (1) To lower the head and trunk as soon as possible; (2) to draw the tongue forward; and (3) to begin artificial respiration. In addition, to use at the same time, (4) heart massage (vigorous rhythmical pressure on the precordial region in time with the heart beat); also occasionally to employ injections of camphor oil. In several cases of severe cardiac collapse I obtained very favorable results by (5) completely inverting the

patient so as to place him as nearly as possible on his head. In two cases of this kind, in which artificial respiration and the other measures referred to had failed to give satisfactory results, it was demonstrated with the accuracy of a physiologic experiment, that inversion of the patient was followed by return of the pulse and respiration; while as soon as he was laid down again and the operation resumed, collapse recurred, which again subsided as soon as the patient was inverted, and so on, several times in succession.

In the end both patients were saved, and so far, although I have performed many operations under general anesthesia—fortunately without a death occurring—I am becoming more and more cautious, because in the course of years some very sad cases have come to my knowledge, even cases in which young persons died from anesthesia in simple operations for strabismus. I therefore still hold to the opinion given by me publicly years ago—namely, that it is not permissible, for the sake of such a trivial operation as that for strabismus, to risk a patient's life by total anesthetization. After writing this I once allowed myself to be persuaded by a young woman, against my own injunction—although it is true that this particular operation for strabismus was a complicated one (tenotomy and advancement)—to use a general anesthetic (chloroform), and this same young girl barely escaped dying under the anesthetic. Although of a blooming appearance and possessed of perfectly normal heart and lungs, she developed a very bad cardiac weakness which required an hour of most energetic treatment.

It is my rule never to employ total anesthesia unless attended by at least two assistants, so that every resuscitating procedure may be performed correctly, vigorously, and persistently without fatigue on the part of the operator.

I formerly used bromethyl [ethyl bromid] occasionally because, owing to its rapid and brief action, it is very convenient for many cases; but gave it up entirely after

witnessing a person who is very near to me develop grave cardiac weakness lasting thirty-six hours (so that for some time the pulse could hardly be felt), after anesthetization with bromethyl for the purpose of extracting a tooth (at which I assisted). The attack in this case must have been due to bromethyl anesthetization and could not be attributed to anything else; possibly the patient may have had an idiosyncrasy for the drug. Ethyl chlorid possibly has some advantages over bromethyl; but I have never had any experience with it in operations on the eye.

For short operations of this kind primary ether anesthesia has been recommended and when successful is very convenient. The patient is made to take ten to fifteen deep inspirations of ether, after which short operations can be carried out without giving pain—as I have often convinced myself—and the patient feels as well as before as soon as the operation is over.

[Ether is far safer than chloroform. According to H. A. Hare, the mortality due to etherization is about 1 in 20,000, or, according to the combined statistics of Julliard and Ormsby, in 407,553 cases there were 25 deaths, or 1 in 16,302. Again, to quote Hare, compared with this statement, the record of chloroform is as follows: The mortality based upon many tens of thousands of cases in which chloroform has been used is about 1 in 2039 (Gurlt); or, according to the combined statistics of Julliard and Ormsby, in 676,767 administrations there were 214 deaths = 1 in 3162. Chloroform is, therefore, fully five times more dangerous than ether. The practice of beginning an anesthesia with nitrous oxid which is to be continued with ether or chloroform obviously possesses many advantages. The same remark applies to primary inhalation of ethyl chlorid.—Ed.]

Local Anesthesia.—In view of what has been said I have endeavored, since the introduction of cocain, to substitute local for general anesthesia as much as possible in operating on the eye.

For a slight operation on the conjunctiva and cornea

the installation of a 1 to 2 per cent. watery solution of cocain for from five to ten minutes is quite sufficient; but for excision of the iris, if the anesthetizing action is to penetrate as far as that membrane, the instillation of a 5 per cent. solution for a half hour, every three minutes, is required, and the eyes should be firmly closed during the intervals between installations, so as to prevent the cornea from being roughened by the action of the cocain and thus having its transparency impaired. When the iris is inflamed, even this protracted instillation is not quite enough; of this more will be said presently. In order to perform a really painless operation for strabismus, it is necessary to inject a few drops of a 3 to 5 per cent. solution under the conjunctiva at the spot where the tendon is to be removed or advanced. After that, however, the operator must wait five minutes before beginning, and it is well to employ this time in distributing the fluid by gentle massage of the lid, so as to prevent its bringing about any changes in the operative field and thus rendering the operation more difficult.

Ever since the year 1886 I have used this subconjunctival injection of cocain in operations for strabismus and have never had bad results. At the worst, the operation is occasionally followed by a little vomiting in the case of sensitive patients. The small quantity of cocain is amply sufficient to render the tenotomy and advancement painless. Whenever cocain is injected, however, especially when a little extra quantity is required, it must be remembered that even cocain may be dangerous if too great a dose is employed. In no case should more than 0.05 gm. be used altogether in operations about the head; if possible, one should try to get along with less. We should always remember the sad case which occurred when cocain first came into use, and when its dangers were too little known. A surgeon injected cocain for a trivial operation that he was about to perform: the patient immediately died, and the doctor, overcome by the calamity, sent a bullet through his brain.

For some time I have even performed enucleation in suitable cases—that is, in non-inflammatory cases, when there is no reason to suspect adhesion of the bulb to Tenon's capsule—practically without pain after the injection of a weak cocain solution: First inject a considerable quantity of the fluid at the four insertions of the rectic muscles, and, after the tendons have been cut, make an injection with a curved needle at the posterior pole of the eye. During recent years a weak mixture of cocain and eucain has been used for this purpose, and the quantity injected is large enough to give the concomitant effect of infiltration—anesthesia after Schleich.[1]

This method is even better and less dangerous, especially when it is possible to inject some of the fluid into Tenon's space. With this method, also, the operator must wait five minutes before beginning. This local anesthetization in enucleation is particularly useful in the numerous cases in which the operation is performed on account of hemorrhagic or some other form of advanced glaucoma; for such patients, as a rule, have diseased blood-vessels and a diseased heart—that is, defective circulation, and are often of advanced age. For the enucleation of an eye that is giving pain, Snellen recommends the injection of cocain with a Pravaz syringe into the vitreous body through the sclera, and asserts that this materially diminishes the sensibility of the eye. When the eyes are soft, as, for instance, after cyclitis, the procedure at the same time raises the tension of the eye-ball and thus facilitates the operation.

For the removal of the lachrymal sac, a preliminary injection of the cocain and eucain mixture may also be recommended, providing the operation can be performed in a non-inflammatory region. The fluid must be injected slowly and a considerable quantity must be used.

[1] Schleich uses a stock solution of eucain β and cocain hydrochlorate, āā 0.5 gm. (gr. viij), absolute alcohol 4 gm. (ʒj), distilled water 16 c.c. (℥ss). Two parts of this solution are mixed with eight parts of freshly boiled water in a graduated pipet.

Local anesthesia is considerably more difficult in acute glaucoma or acutely inflamed eyes in which iridectomy is to be performed. In such cases the iris is extremely sensitive, and even the previous injection of cocain solution under the conjunctiva at the spot where the keratome is to be introduced into the anterior chamber, as recommended by Koller, has not always proved sufficient in my experience to enable the operator to seize and excise the iris without giving pain and causing the patient to move. In such cases I have for years resorted to the expedient of using pure cocain, taken directly out of alcohol and allowed to crystallize, so that it is perfectly sterile, using a German silver spatula for the purpose of introducing it into the anterior chamber, and applying it directly to the iris after I have made the incision. In that way the pain may, as a rule, be greatly diminished and in many, although not in all, cases entirely abolished. Total anesthesia, which in such cases of acute glaucoma appears to be very much indicated, and is, in fact, regularly employed by some operators, if only to enable them to carry out the operation quickly and methodically, does not always facilitate iridectomy—which in such cases should be made above the pupil whenever it is possible—as much as is desirable, because of the upward rotation of the globe. Besides, it is, as has been said, dangerous in glaucomatous patients.

The application of a thin layer of cocain in crystals is a method that I have employed for some years, even in slight operations on the lids and on the globe, in which the incision is made through the conjunctiva (removal of chalazion).

During recent years cocain has gained an ally in the extract of the adrenal gland, one of the constituents of which, when the solution is applied to a mucous membrane, causes vigorous contraction of the blood-vessels in a very short time. This prompt constricting action is possessed in a remarkable degree by *adrenalin* (Solutio adrenalini hydrochlorici), which is prepared by Dr. Takamine, in America, and sold by Parke, Davis & Co., in

New York and London. This preparation also has the advantage of being stable and clean, and a very weak solution of it possesses a marked action, as I discovered long ago. By instilling a very few drops of adrenalin at intervals of a few moments, the redness can be made to disappear temporarily, if not wholly at least in part, from inflammatory or hyperemic eyes. After this has been done, the cocain, as a rule, develops its action more readily. Whether in glaucoma the action of cocain on the iris can be rendered sufficiently powerful with the aid of adrenalin I cannot say, as I have not had sufficient experience in the matter. That adrenalin is very valuable as a hemostatic I can confirm from my own experience. Ophthalmic surgeons have, however, long been familiar with artificial anemia as produced by clamping the lids with the instruments devised by Desmarres, Snellen, and Knapp, and the method is used to great advantage in many operations on the lids. But when these clamps can not be applied to the lids, as in extirpation of the lachrymal sac, and sometimes in operations for strabismus, etc., the use of adrenalin offers distinct advantages, for the lids and surrounding tissues are extremely vascular, so that hemorrhage is often very profuse and interferes with the operation. My experience in this matter has taught me that by adding to the fluid (cocain, cocain-eucain) which is injected in the tissues underneath the conjunctiva, etc., for the purpose of inducing local anesthesia, a very small quantity (1–2 drops of adrenalin solution), it is usually possible to reduce the hemorrhage, especially the capillary hemorrhage, in the most welcome manner. Sometimes it is possible to render the tissue practically bloodless, as, for example, in Kuhnt's operation for ectropion. It is well to be cautious with the dose of adrenalin and to confine one's self to the minimum that is required. Adrenalin chlorid solution (Takamine) directly mixed with more or less of a 1 to 2 per cent. solution of cocain is generally used.

[Very satisfactory local anesthesia can be produced with beta-eucain and adrenalin chlorid. Professor Arthur

E. J. Barker has recently recommended the following solution:

Pure chlorid of sodium	0.8	gm.
Beta-eucain	0.2	"
Adrenalin chlorid	0.001	"
Distilled water	100.	"

If as much as 50 c.c. of such a solution were injected, only $1\frac{1}{2}$ grains of beta-eucain and 1 mg. of adrenalin chlorid would have been employed. In many operations around the eye a much smaller quantity would suffice. It is necessary to wait from fifteen to twenty minutes after the injection before the edema disappears and the full effect of the adrenalin chlorid has asserted itself.

Professor H. C. Wood suggests that the efficiency of these solutions might be increased by adding to them not only beta-eucain, but also cocain.—ED.]

Whenever the capillary bleeding is severe enough to be troublesome in work on the lids, plastic operations in the neighborhood of the eyes, extirpation of the lachrymal sac, and the like, it is a good plan, while operating, to apply small pledgets of cotton saturated with adrenalin cocain to the bleeding points from time to time, with moderate pressure. In this way the preliminary injection of the hemostatic fluid into the tissue can be supplemented and less adrenalin will be required.

One of the most important and most difficult tasks of the ophthalmic surgeon is the proper management of

Sterilization, Antisepsis, and Asepsis.

The battle with the micro-organisms which interfere with the healing of wounds must be carried on with the same weapons in operations on the eye as in other surgical procedures on the human subject; and, although vigorous measures are required, they must be undertaken with due caution, owing to the delicate structure of the organ. It is most important to fight the micro-organisms at the right

spot and at the right moment; it would be wrong to rely on the asepsis of the operating room, the sterilization of instruments, and the like, and overlook individual local peculiarities of the operative field and the dangers incident thereto. In cases involving the opening of the capsule of the globe (cataract extraction, iridectomy, etc.), more than in any other, the surgeon must carefully determine beforehand what is the proper thing to do in any individual case—whether the aseptic or the antiseptic method is to be used. While the surgeon must practically become a pedant in the observance of aseptic and antiseptic precautions, it is equally important, on the other hand, to guard against becoming a slave to routine.

For example, it would be quite wrong to assume that the rules followed when dealing with a cutaneous region, which is so cleansed that the entire operative field remains aseptic, can be directly applied to operations on the eye and will result in aseptic healing of the wound. Such an assumption is wrong, for the simple reason that, as will be explained more in detail, the ophthalmic surgeon is never certain that he is operating in a sterile field. Hence, although he may have taken every precaution dictated by a scrupulous aseptic technic, he will occasionally have trouble with the healing of his wound and will soon realize that the eye is a peculiar region as regards operations.

It is true that even before the period of asepsis, when nothing was known of the methods of fighting microbes—that is, by antisepsis and asepsis, and even prior to the dissemination of a clear idea of the elementary principles of cleanliness in operations on the eye, many such procedures, as hundreds of observers could testify, turned out remarkably well. Nevertheless, however, as large a proportion as twenty or even thirty out of every hundred eyes performed on for cataract went blind from purulent or nonpurulent inflammation before the advent of antisepsis; although the eye has fortunately exhibited a marked tendency toward recovery after operative and traumatic wounds.

On the other hand, even the most scrupulous cleanliness and the observance of all the rules that have been set up by the doctrine of sterilization and asepsis in the treatment of wounds, do not always suffice to guarantee, as it were, an uncomplicated healing and completely to make good the loss of tissue in the same way as is now possible in many operations which are much more dangerous and extensive and were never even attempted before the period of antisepsis. We have, undoubtedly, reduced the percentage of losses in cataract operations in the most gratifying manner, from 20–30 per cent. to 1–2 per cent., by adopting the modern treatment of wounds in surgical procedures on the eye; but we have not yet succeeded in bringing about what ought to be the aim of every ophthalmologist—namely, to reduce it to zero with absolute certainty.

To judge from the publications found in modern literature bearing on this point, it might almost be supposed that failures in surgical treatment for cataract are a thing of the past. This optimistic presentation of actual conditions is partly explained by the fact that an operator nowadays may easily perform at least 100 or even 200 successful operations for cataract without losing an eye, and, if he makes up his statistics from such a favorable series, he will not have any failures. An experienced ophthalmologist will in this respect, however, hold to the dictum of Knapp that "If the statistics are large enough, everything is possible"—*i. e.*, if a surgeon performs on a sufficiently large number of subjects, he will see everything from suppuration to sympathetic disease of the other eye. Hence, if we are to have accurate statistics on this question, they must be based on a large number of cases, as was done by Arlt thirty years ago when he gave the most instructive account of the results of his proceedings for cataract. The reports that have frequently appeared during recent years from individual clinics to the effect that from 100 to 200 operations for cataract resulted in recovery without a single failure prove nothing whatever as to the method employed, since the same figures were obtained by Horner, whose technic consisted merely of cleanliness. If we wish to know the truth about the percentage of failures at the present time, we only need to examine the literature of subconjunctival injections of bichlorid of mercury and salt solution and the literature of intraocular disinfection, and we shall see how often, even in the most recent times, suppuration and slowly progressive inflammation in instances of cataract have been combated and improved by the above-mentioned methods, or have continued their destructive course in spite of them.

In order to gain a clear understanding of the present state of these questions relating to the treatment of wounds of the eye, it is necessary to go back to the historical development of these matters. The effort to improve the results on the eye, especially operations for cataract, and render them more certain, date chiefly from A. v. Gräfe. It was quite natural and in accord with the views of his time that von Gräfe should have made the most of the mechanical conditions, particularly the size and position of the incision, as factors in bringing about a smooth recovery. For even at that time it was easily observed that a small puncture of the cornea (paracentesis) rarely resulted badly, especially by suppuration ; and even after the somewhat larger incision and more serious interference involved in the excision of a piece of iris (iridectomy), purulent inflammation was quite a rare event ; while, on the other hand, it not infrequently followed the still more serious operation for cataract, in which the incision has to be made three to four times as large as in the case of an iridectomy. As at that time it was not customary to perform an iridectomy when operating for cataract, it was quite natural that the size of the corneal incision was made chiefly responsible for the occurrence of a purulent inflammation.

Von Gräfe, therefore, quite naturally and logically bent his efforts toward diminishing as much as possible the size of the incision in cataract operations. But at the same time—and this is very important—he tried to make the incision of such a shape as to enable the wound to close up and the edges to unite as rapidly and as perfectly as possible. With a fine instinct he thus established one of the fundamental principles of the healing of wounds, which still holds good at the present day and which was never fully understood until now. The reason why rapid and perfect closure of the wound is such an essential condition of ultimate recovery will be seen from what follows.

The better results as regards suppuration of the wound,

which were obtained with von Gräfe's "linear extraction," as compared with the results obtained by means of the earlier method with a large corneal flap, as the statistical reports of the times clearly prove was the case, are, in my opinion, chiefly attributable to rapid closure of the wound.

Before Lister finally pointed the way for the proper treatment of wounds, many a surgeon did his utmost to improve the conditions of wound-healing by insisting on the observance of the greatest possible cleanliness. The same principle was adopted by ophthalmic surgeons, among whom Horner should be specially mentioned. He reduced the percentage of failures to 2.67 per cent., as is shown by the statistical report of more than 1088 of his cataract cases. Among 737 cases of uncomplicated cataract on which he operated between 1870 and 1880 the percentage of failure was only 1.6 per cent. From 1877 to 1880 he became more and more strict as regards cleanliness.

It was not, however, until a more intimate knowledge of micro-organisms and their influeuce on the healing of wounds had been obtained that the ophthalmic surgeon obtained the proper weapons. It was far from easy for this new knowledge to gain recognition, and I always find it most instructive when I remember that almost thirty years ago, when, as Eberth's assistant, I made the acquaintance of the pathologic micro-organisms during a long course of tedious labor with my revered teacher in a pathologic institution—even though hampered by the apprehension of ridicule from others—for nobody would believe in the "stuff." Then, after I had thoroughly learned the lesson of cleanliness from Horner, and the antiseptic method of treating wounds from R. Volkmann, in Halle; and Lister, in Edinburgh, I became convinced that equally great progress could be made in the treatment of wounds of the eye as in other operative fields, and, acting on this conviction, I applied the principles of Lister's teachings to the very first of my operations in

1878, not, of course, without modifying them to suit the delicate structure of the eye, and not without first having tested the effect of carbolic acid on the eye by means of animal experiments. Finding that the cornea did not tolerate a 3 per cent. solution of carbolic acid very well, and a 5 per cent. solution still less, except when active irrigation was kept up, I for some years used for the preliminary cleansing of the conjunctival sac a cold, saturated salicylic-acid solution, and after the year 1887 a bichlorid solution of 1 : 5000, and in suspicious cases, 1 : 1000; and I still adhere to this method at the present time. It has also been my constant practice to keep all the instruments in a 3 per cent. solution of carbolic acid, and to return them to this solution during the operation—that is to say, operate with wet instruments, and to some extent I still adhere to this custom.

As Lister's dressing, on account of its stiffness, was not applicable to the eye, I, from the beginning, employed the wet salicylic-acid dressing, such as Horner used for cases that threatened suppuration or had already developed suppurative inflammation. The cotton was moistened with a cold saturated 3 per cent. solution of salicylic acid, applied to the eye and constantly kept moist by the addition of more solution.

Since my first extraction of cataract I have never performed an operation without first injecting the lachrymal canal for the purpose of ascertaining the possible presence of cartarrh in it or in the lachrymal sac, as a result of more or less marked stenosis. For it has been known for the past thirty years that the source of a purulent infection of the eye is often situated in the lachrymal sac, the secretion of which, even if it is only produced in small quantities, is usually highly infectious and has been the cause of many a rapidly progressive suppuration after an extraction of cataract—such as rendered life a burden to the ophthalmic surgeon before this fact was properly recognized. Whenever I ascertained that the fluid injected through the lachrymal sac and the lachrymonasal

canal did not return clear or failed to reappear, the condition was at once corrected by suitable means, as will be described more in detail later on.

This antiseptic precaution exercised a favorable influence not only on the percentage of failures, but also on the subsequent course of the case, by bringing about a simple and uninterrupted recovery. Iritis and slowly progressive cyclitis occurred less frequently after operations for cataract and iridectomy. The failures on account of suppuration in my first series of 400 cases for cataract, collected by Dr. Arnold, were reduced to 1 case, or 0.25 per cent., and in my first 540 operations for cataract (including all of them) to 0.37 per cent. of failures from suppuration.

These favorable figures were quite evidently due to the antiseptic precautions; but it seemed desirable to determine this point more accurately and at the same time to find out why the recovery is occasionally unfavorable.

When I undertook this task with my assistants and students Hildebrandt, Bernheim, and Marthen, the question was anything but clear. Schmidt-Rimpler, Sattler, Weeks, and others had shown that pathogenic microbes are often found in the conjunctival sac, especially in eyes suffering from purulent catarrh of the lachrymal sac, or catarrh of the conjunctiva. They had also shown how and with what materials the antiseptic precautions which are thereby rendered necessary can be carried out in the eye. The investigations of Gayet, however, show that in spite of thorough irrigation of the conjunctival sac with a bichlorid solution of 1 : 6000 and with a saturated boric-acid solution, a quantity of microbes are found when a culture is taken immediately before an operation for cataract. But even those cases in which such a culture was found to be positive and in which living cocci were still present, in spite of the previously described irrigation, very often made an uninterrupted recovery. On the other hand, Sattler and E. Meyer read a paper before the Seventh International Ophthalmological Congress in Hei-

delberg, in which they asserted that they had sterilized the conjunctival sac by antiseptic measures, although Chibret on the same occasion stated that he could not report a similar result.

It seemed to me, therefore, most important to determine, by taking careful cultures (most of which I took myself), the effect of the various antiseptic procedures that are possible in the eye, and the quantity and variety of the micro-organisms before and after the cleansing, both in the conjunctival sac and on the edges of the lids. A considerable number of such cultures were thus taken from human eyes which had first been infected by the introduction into the conjunctival sac of virulent Staphylococcus pyogenes aureus. Attempts were made with all kinds of antiseptic procedures to remove these cocci. Most of the investigations were made by taking cultures before and after operations for cataract. At the same time the effect of the antiseptic procedures was controlled quantitively—*i. e.*, by counting the cultures which had never been done before. The astonishing fact was revealed that it was impossible, with any of the antiseptic methods known at that time and permissible in the eye, to render the conjunctival sac or the edges of the lids free from germs. The best result obtained, and not even that in all cases, was a diminution in the number of germs and sometimes a less perfect growth after the cleansing. Bernheim found that mere mechanical cleansing by rubbing and washing with physiologic sterile salt solution, for example, was followed by a considerable diminution in the number of germs; and if the original number of germs was small, these measures were quite sufficient to bring about an approximate freedom from germs. An important result of our investigation was to show that the edges of the lids—as I had expected—play a very great part in the pollution of the eye with microbes; for the latter are often found in that region, and from there may at any time enter the conjunctival sac. As the palpebral margins, owing to their numerous glands and their cilia, are even

more difficult to cleanse than the conjunctival sac, it is easier to understand that the latter may be constantly reinfected from the edges of the lids. In addition, Marthen's investigations showed that the dressing, by interfering with the normal movement of the lids and producing a uniform heat, tends to increase the number of germs; but the increase was less marked when the dressing was kept moistened with a bichlorid solution of 1 : 5000.

Bernheim, and later Marthen, also established the important fact, which was not known at that time and has since been confirmed by Bach, Helleberg, and others, that the lachrymal fluid possesses a certain bactericidal quality which, although not very powerful, yet makes itself distinctly felt in the presence of not too great a number of microbes, even if they consist of Staphylococcus pyogenes aureus. This action of the tears is no doubt largely responsible for the fact that wounds of the eyes very often heal kindly, even without any antiseptic treatment.

Similar results showing the insufficiency of antiseptic procedures on the eye were obtained by Franke, Bach, Dalen, and many others who investigated this matter. The two last-named authors found that as much could be accomplished with mere mechanical cleansing with physiologic salt solution as by the use of bichlorid and other substances, and ultimately Bach pronounced the former procedure the most effective for the purpose of obtaining relative freedom from germs, although Franke does not agree with him.

It appears, therefore, from these important investigations that with the methods of cleansing at present in vogue we are unable, in operations on the eye, to sterilize the operative field sufficiently to be able to count on a smooth recovery. Nevertheless, scrupulous cleansing, as our investigations also showed us, diminishes the number of germs and sometimes reduce it to zero. On the other hand, the dressing may again increase the number of microbes on the palpebral margins and in the conjunctival

sac by limiting the movement of the lids and maintaining a uniform heat, which is favorable for the growth of micro-organisms—that is to say, by furnishing an undisturbed incubator. The closure of the lids hastens the flow of tears, and with them any germs that are present in the conjunctival sac are washed out through the lachrymonasal duct and thus prevent the undisturbed stagnation of the discharges from the wound and of the lachrymal fluid, which is so favorable for the growth of bacteria.

Hence, even if the operative field is carefully washed off and rubbed off before, and again washed off after the operation, so as, in a favorable case, to reduce the germs to a minimum by these measures, their number may again become quite considerable after two or three days, and there is, therefore, always danger of secondary infection of the wound.

It should follow that no dressing should be used and that the eyelids should be allowed as much freedom of movement as possible. But the patients usually prefer to keep their eyes closed at first because they find it more agreeable. Theoretically it is quite correct, after one or two days have passed and the first irritation of the wound has subsided so that the eyes can be opened, to apply a wire-screen dressing, to reassure both the patient and the physician that the eye will not be inadvertently touched with the finger; but my patients, as a rule, prefer the dressing, as they find the wire screen unpleasant.

Many operators have adopted this "open treatment of wounds"—as it has been incorrectly called—and have recommended it warmly; but the expression is a bad one, and here again the eye presents conditions which are quite different from those which obtain in other regions of the body. For even if no dressing is used, it does not by any means insure an "open treatment of the wound." In most of the operative wounds that are here under consideration the lids immediately close over the wound and thus furnish the first suitable covering.

Further, it may be said that the more constantly this natural covering is left in place during the first few days, the less will the closure of the wound be disturbed; and this brings us to what is, in my opinion, the most important principle in the treatment of wounds of the eye. Primary union of the wound in as short a time as possible is the thing, above all others, to be aimed at, in order to insure freedom from infection during the healing; for it offers the best protection against the invasion of pathogenic germs. This axiom is by no means contradicted by the fact that the eye after an operation for cataract, when the wound fails to close after several days and the anterior chamber is therefore obliterated, is for that very reason almost absolutely protected against purulent infection of the wound. The latter may, however, occur immediately if the anterior chamber is restored or, in other words, the wound finally closes. The fact that it does not occur before is probably due to the flow of aqueous humor, by which the wound is constantly bathed; although, as the investigations of Marthen, Bach, and others have shown, the fluid possesses no germicidal power. When the wound is slow to close in this way, irritation and inflammation in the anterior chamber are often observed secondarily. It is also important to prevent with every means at our disposal the reopening of the wound by mechanical influences so long as the wound can be spread open—that is to say, has not sufficiently healed. Whenever prompt primary union of the wound is achieved and maintained, the conjunctival sac may contain virulent bacteria without necessarily causing infection of the wound.

Bearing these points in mind, the operator will, first of all, in every case keep the eye that has been operated upon as quiet as possible for twenty-four to forty-eight hours by means of a dressing that will take up the lachrymal fluid, so that the dangerous attempt to wipe the eye will be rendered not only unnecessary, but will be absolutely impossible. In the second place, it will be necessary to protect eyes that have been operated upon against a blow or

against rubbing for from ten days to two weeks, so as to guard against reopening the wound. In this connection I may give the following facts, which I have learned by experience: The time required for firm union of an iridectomy wound after an operation for cataract or glaucoma varies in different individuals, and it is therefore necessary to individualize carefully. In moderately vigorous persons, even of advanced age, if the tissues are in fairly good condition, moderately firm closure of the wound will have taken place in from eight to ten days, and provisional healing may be said to have taken place. On the other hand, debilitated and very senile individuals, especially if their digestion is poor, may require twice the time. I once had this most unpleasant experience in the case of a very old man who was so unusually pale and emaciated that, when he closed his eyes, he looked exactly like a corpse. As he assured me that he had had this appearance for many years and felt quite well, and as he urged the procedure, I operated in spite of these unfavorable conditions. Recovery was quite satisfactory, and two weeks after the operation I could determine a visual acuity of $\frac{2}{3}$ and could order the glasses. The dressing was then removed. The next day the eye was somewhat reddened, so that I would not allow the patient to start on his homeward journey. The day after that, to my great consternation, a small hypopyon had appeared in the anterior chamber, and on careful examination of the eye I found a very small piece of vitreous in the wound, or rather in the scar. On careful questioning, I found that he had rubbed his eye during the night after I had examined his eyes and had felt a little pain. He evidently had reopened the wound at that time and the result was that the eye was almost lost. Beginning at the wound, a partial purulent opacity of the vitreous developed, and, after a very tedious and painful after-treatment, lasting several weeks, I finally discharged the patient with a visual acuity of $\frac{1}{10}$.

That reopening of the wound on the sixth to eighth

day after the operation may be promptly followed by purulent infection of the wound and loss of the eye is a matter of general knowledge. As early in my career as the time when I was assistant to Horner I saw such cases develop on the eighth day, and in my own cases once on the sixth and eighth day after a perfectly normal operation.

For this reason the eye after operation should be carefully protected for from eight to ten days against a blow or even contact with the patient's hand, which is often anything but gentle. Whether this is accomplished with a dressing or with the wire screen is immaterial. During the night a well-applied dressing will be most grateful to the patient. If it is desired to make it still more secure, a wire screen, after Fuchs' or Snellen's aluminium shield (scale), may be advantageously inserted in the bandage. During the day a wire screen, after Fuchs', Praun's, or any other pattern, by itself will suffice. Here again the individual must be studied. As long as there is lachrymation a little cotton or gauze should be kept constantly on the eye to absorb the escaping fluid and obviate any wiping or rubbing on the part of the patient and to prevent excoriation of the lids and surrounding skin. This may be covered with a wire screen or a shield, or merely with a little more cotton, and then fastened with a roller bandage. Some eyes do not bear a dressing so well as others, because the edges of the lids become red and the skin soon begins to show excoriation, especially near the external canthi. In such cases it is particularly advisable to use only a wire screen for the first two days succeeding the operation, unless there is lachrymation, a condition which also varies in different individuals.

Bandaging.—Aside from certain modifications and peculiarities, which will be discussed more in detail when I come to speak of the post-operative treatment of cataract, the best way to construct a bandage either for one or for both eyes is as follows: An abundance of absorbent cotton is laid on the eye in such a way as to fill out the

depression around the globe—that is, the hollow between the arch of the nose and the eye and between the upper margin of the eyebrow and the eye, etc., with moderately large flakes of cotton, while the bulbar prominence is covered with a thinner layer, so as to obtain a uniform padding extending from 3–5 cm. behind the palpebral fissure in all directions. The cotton is held in place with a roller bandage 3–5 cm. in length and 5 cm. wide, consisting either of closely woven cotton cloth (muslin) or of gauze, with or without starch. Starched bandages are the best and should be moistened before they are applied, because, as the dressing dries, the turns of the bandage stick together, and the dressing, which also adheres slightly, is less apt to be displaced and is, therefore, always firm even if the individual turns are not drawn tight. In applying a bandage after operations on the eye pressure must be avoided, with one exception, which will be mentioned later. The end of the bandage is placed slightly in front and below the patient's ear and held in place either by the patient or by the surgeon himself, who fixes it with one hand while he makes the first turn of the bandage with the other. For one unpractised it is better to allow the patient to fix the bandage, as it leaves both hands free to manipulate the roller.

If one eye only is to be covered—*monoculus*—the first turn is carried upward from the angle of the jaw on the same side, over the pad of cotton on the eye, and the opposite frontal eminence, around the head, returning underneath the ear or over the lower portion of the ear to the starting-point. The second turn passes over the eye at a somewhat higher point and touches the opposite frontal eminence at a point somewhat lower; it then passes around the head, covering a higher portion of the ear or missing the ear altogether. The third turn is placed almost horizontally across the upper portion of the cotton pad and the superciliary region of the other eye—*i. e.*, it passes horizontally around the head. The fourth turn follows the same path as the third; and, finally, a few more turns

of the bandage are applied, which again pass underneath the ear. These last turns, which are drawn tight over the lower portion of the cotton pad over the eye, and cover the side of the face, rising gradually so as to lie parallel to the nasolabial fold, are very important, as they prevent the patient from getting a finger underneath the dressing. Educated as well as ignorant patients often have the bad trick of trying to rub the eye underneath the bandage whenever they feel any itching, a proceeding which is, of course, most dangerous.

The double bandage—*binoculus*—which should be worn for from twenty-four to forty-eight hours after an operation for cataract, because more perfect rest is assured to the affected eye by putting the other eye at rest also, is begun at the same point as the single bandage; but the first turn of the bandage is carried from the forehead to the occiput, and forward over the ear on the same side as the wounded eye; it then passes over the frontal eminence on that side and obliquely upward over the other eye, which has also been covered with a cotton pad. The bandage is then carried around the back of the neck, and back to the starting-point of the first turn—*i. e.*, to the angle of the jaw on the operated side. A second turn is then carried over the operated eye, somewhat higher than the first, and passes down correspondingly lower on the opposite side of the head. This second turn is also carried over the occiput, the ear, and the frontal eminence of the same side, then down over the other eye, and finally back again to the operated eye by way of the back of the neck, passing under the ear of the same side, and so on. The double bandage is firmer than the single bandage, because it covers the head more completely, and because some of the turns pass below the occiput, and over the back of the neck, so that there is no danger of the bandage slipping down, an accident which must be particularly guarded against in the case of a single bandage. When a moistened-starch bandage is used, the auricular region

must be protected with cotton to prevent the turns of the bandage from cutting into the ear as they harden.

When a light single bandage is desired, as in summer or when there is not the same strict indication for absolute rest and protection of the eye (after-treatment), a loosely knitted bandage 30 cm. in length, 8 cm. broad in the middle and tapering somewhat toward the extremities, which is provided with tapes, may be recommended. [A comfortable light dressing may be composed of an oval of sterile gauze, over which is placed a suitable pad of cotton, held in place with a few strips of surgeons adhesive plaster, which pass from above the brow to the cheek.—Ed.]

The first requisite of a dressing that is applied after an operation—and in fact of any dressing, with few exceptions—is that it shall not exert pressure and still be firm enough not to be readily displaced by slipping, as that would exert an undesirable pressure on the eye. Nothing is more calculated to delay closure of the wound after an operation for cataract or an iridectomy (glaucoma) than a too tightly applied dressing. The pressure of such a dressing constantly reopens the wound, and the patient is very apt to try to overcome the unpleasant sense of pressure by closing the lid tightly, and thus makes matters worse. If the bandage is too tight, the tears are prevented from reaching the palpebral fissure, because the lids are pressed tightly together, and in this case also the patient adds injury by closing his eyes still more firmly. The tears collect under the lids, blepharospasm increases more and more, and finally there is severe pain and, of course, injurious pressure on the wound, and harmful retention of the secretions, both from the wound and from the conjunctiva.

I therefore agree with Snellen, that a bad dressing does more harm than good. But for all that, I am far from advocating "treatment without bandaging"; on the contrary, the surgeon should learn to apply the dressing correctly and intelligently, and should remember that very much depends on the dressing in the most important operations on the eye. It is always best to entrust the first dressing after an operation for cataract or glaucoma

only to experienced hands; beginners usually try to draw the bandage too tight.

The dressing should be so applied as to insure the greatest possible degree of rest in the operative field without disturbing the flow of tears. Hence, certain mechanical factors which help to support the eye after operation must be taken into account, so as to enable the organ to develop its inherent tendency to recover.

This brings us to the next question: Shall we assist this natural healing process still more by the use of antimicrobic drugs, and how far may we go in that attempt?

Modern surgery, as everyone knows, has developed a method of treating wounds which is known briefly as the aseptic method and is based on careful investigations and a large experience. The aseptic method, which was evolved from Lister's antiseptic method, is based on the principle that when no microbes are present, the use of germicidal drugs, such as carbolic acid, bichlorid of mercury, and the like, must be avoided, because they irritate the tissues unnecessarily. The rules in regard to antisepsis and asepsis which must be observed by the surgeon are deduced from the following axioms, which are based on numerous accurate investigations:

1. Pathogenic germs do not enter a wound through the air, as was believed by Lister, who under that impression enveloped the wound in a mist of carbolic acid produced by a carbolic-acid spray.

2. In a healthy body the infection of the wound does not take place through the blood- or lymph-channels—that is, the infection is never from within (endogenous).

3. As a rule, infection is derived from the fingers, instruments, and dressings with which the wound comes in contact (exogenous).

4. Special care is required to see that the tissue through which the incision is made is as free from germs as possible.

5. Antiseptic precautions are necessary in the cleansing of the hands of all those who have to do with the opera-

tion and with the care of the wound, also in the washing of the instruments and all other objects that may come in contact with the operative field. Finally, the skin where the wound is made must, of course, be rendered as free from microbes as possible.

After the operative field and everything that comes in contact with it has thus been rendered sterile, there is no further need of antiseptics—the wound remains aseptic because there are no germs present; nor need the dressing contain any antiseptic substances. Hence, there is no need of an antiseptic fluid for irrigating purposes during the operation, nor of an antiseptic solution to hold the instruments during the operation, to prevent blood from adhering to them; sterile water is all that is necessary to wash the blood from the wound, the instruments, and the hands of the operator and his assistants.

As soon as the operative field and everything that comes in contact with it has been rendered free from germs, asepsis begins. In order to achieve freedom from germs antiseptic and sterilizing procedures must be employed. These procedures are at present much more effective than were those known to and used by Lister. Carbolic acid, which was exclusively used in his time, has been replaced by bichlorid of mercury, which is more certain in its disinfecting action, especially for the sterilization of the skin. Detailed investigations, especially by Schimmelbusch, have shown that the most certain and most rapid method for sterilizing instruments consists in boiling them in water to which a little soda has been added, and that the surest and most convenient method of rendering sponges, pads, bandages, operating gowns, and the like sterile is by means of steam.

In the modern aseptic method, therefore, antiseptics such as carbolic acid, bichlorid of mercury, etc., are not allowed to come in contact with a recent wound, so as not to injure the tissues, and allow them to institute the reparatory process as rapidly as possible. In this connection I wish to point out that Lister (more so than

many of his followers in antisepsis) always used carbolic acid most sparingly on the wound itself, as I know from personal observation. He also protected the wound from the carbolic acid in the dressing by means of a protective (thin wax or paraffin cloth); and when the dressings were changed, he would wash the wound very cautiously with the carbolic-acid solution, and would even omit doing so altogether when it was not necessary. For Lister also believed in the time-honored principles of the English surgeons—to let the wound alone as much as possible, a principle which, I believe, we also should do well to observe.

In the case of wounds that have to be made in organs or parts of organs that cannot be rendered free from germs, an entirely different procedure must be adopted. This category includes all wounds that have to do with mucous membranes exposed to the external air—*i. e.*, those of the mouth or throat, vagina, rectum, or adjoining regions. These mucous membranes are more or less infected with microbes (some of which are frequently pathogenic) and, owing to their many folds, are most difficult to cleanse, and after a few days at the most the operative field will be again invaded by a flora of bacteria. In such cases it is difficult to achieve a satisfactory recovery, and the surgeon is therefore compelled to use active antiseptic precautions not only in the preparation of the operative field, but also later in the treatment of the wound, so as to protect it by weakening as much as possible or even destroying the growth and virulence of the germs that have remained. This must be done by means of antiseptics that do not unnecessarily irritate the wound and its surroundings, especially antiseptic powders such as iodoform, xeroform, airol, etc., which are incidentally also intended to keep the wound as dry as possible by absorbing the secretions—for the growth of microbes always requires moisture. Instead of Lister's carbolized gauze, iodoform gauze and other like preparations are therefore used. The treatment of such operative wounds is similar

to that of accidental traumatic wounds that are already, or may subsequently become, infected.

How do all these things apply to the eye? It is obvious that the eye presents conditions similar to those which exist in the above-described wounds of the second category, with this peculiarity however: that, although most eyes do not harbor any pathogenic germs in their palpebral margins and conjunctival sac, other eyes may be threatened by the very worst and most virulent microbes which may be derived from the lachrymal sac or even from the palpebral margins and from the conjunctival sac. Another feature is that the lachrymal fluid possesses an unmistakable, albeit faint, bactericidal action. It is thus explained why, on the one hand, even a cataract wound may heal kindly without any precautions other than cleanliness, and, on the other hand, the slightest abrasion of the cornea in the presence of numerous infectious germs often speedily becomes the seat of a purulent infection, and in the case of a large incised wound the mischief may run an uninterrupted and most destructive course.

If it were possible, before beginning an operation for cataract, to ascertain positively by making cultures whether or not pathogenic, virulent microbes were present in the eye (including the lachrymal sac), such a precaution would be of the greatest value. But we are unable to determine this, because it is impossible to obtain cultures from all the crannies and recesses in the conjunctival folds and in the glands at the palpebral margins, and still less from the lachrymal sac.

We therefore always have to deal with a more or less hidden foe, because we never know whether the operative field contains infectious, pathogenic micro-organisms or not. For these reasons I am not in accord with many recent ophthalmologists, who seek salvation solely in "the strictest asepsis"—that is, sterilization of the hands, instruments, irrigating fluid for the wound, sponges, etc., in the fond belief that they are taking the same aseptic precautions as

the all-round operator with sterile wounds, if they cleanse the skin surrounding the eye with warm water and soap. Most of them even remove the eyebrows and eyelashes, as a general surgeon would under similar circumstances. In my opinion asepsis in the eye begins at best inside the capsule of the globe—for the interior of the globe may be regarded as free from germs in a healthy eye. But even here the operative field is not entirely sterile, because the incision has to be entered through a non-sterile region (the conjunctival sac), and after the wound has been made, it is in communication with non-sterile portions of the adnexa of the globe (lachrymal sac, conjunctival and palpebral margins). It is therefore wise, in my opinion, to treat our operative field as the general surgeon would treat one that cannot be sterilized. Nothing must be neglected. First, cleanse it of microbes as thoroughly as possible before the operation; and, second, after the operation, every endeavor must be made to arrest as much as possible the growth of any germs that may still be present. It may not be necessary to kill the germs; they need only be weakened to such an extent that their virulence becomes very slight, so as to enable the normal tissues of the eye to carry off the victory in the fight against the invading parasites, which is sure to take place.

This brings us to another important principle in the modern treatment of wounds, and one that also plays an important part in the so-called asepsis. In disinfecting the field before, and in cleansing it during and after the operation, for the purpose of combating the bacteria, the importance of guarding against injuring the tissue-cells of the wound by such antiseptic precautions must always be borne in mind, because by doing so they would be handicapped in their fight against the pathogenic germs.

Hence, if, with the object of severely injuring or even destroying any germs that may be present, powerful disinfectants, such as strong carbolic-acid or bichlorid-of-mercury solutions were to be employed, the tissue-cells would be injured, and many of them might perhaps be

killed. Such a procedure would work more injury than the microbes. After two or three days the carbolic acid or bichlorid of mercury has entirely disappeared from the wound, and if any germs have escaped destruction they will find in the defenseless tissue, which has been thus injured, and perhaps in part destroyed, a most favorable soil for their growth and further propagation.

For these reasons many ophthalmic surgeons have recently adopted the practice of using nothing but sterilized water or sterile salt solution for cleansing the conjunctival sac before and after operation, supplementing this with mechanical cleansing, which some use more vigorously than others. The conjunctiva of the lids, the fornices and the bulb, especially the inner canthus and the site of the incision, are cautiously wiped off, first with sterile pledgets and then with pledgets saturated with the irrigating fluid.

The only antibacterial substances that ought to be used in the wound for the purpose of covering them, for example, are such as do not injure the tissue and continue to remain active until the wound is healed. These indications are met chiefly by antiseptic powders, which have already been mentioned, particularly iodoform. But even these powders, when directly applied to the membrane, cause too much irritation of the cornea, in which or at the border of which the incision in cataract operations and iridectomy is made; the patient is worried, becomes restless, and this interferes with rapid closure of the wound—which is so important—and finally the increased flow of tears produced by the irritation simply washes away the powder; so that at best no benefit has been derived and the patient has been uselessly worried.

But it is quite advisable to apply finely divided iodoform powder at some distance from the wound in the globe, as

1. At the inner canthus—for we know that, owing to the proximity of the lachrymal sac, this part of the eye needs the most careful disinfection.

2. To the closed lids, because the palpebral margins, as investigations in our clinic have shown, are also a special source of danger, and contain many hiding places for microbes that are difficult to reach.

I know from an experience of fifteen years that iodoform applied to the outer canthus and to the lids is neither irritating nor injurious, and I confidently recommend its use as here described. This fact was the subject of a paper that I published in 1891.

But the iodoform must be carefully purified beforehand by washing it for a few days in a 3 or 5 per cent. solution of carbolic acid. It is then put in a covered dish and allowed to dry, in the incubator or elsewhere; after which it must be rubbed up again with sterile instruments, because it has a tendency to form lumps as it dries.

Some persons possess an idiosyncrasy for iodoform—just as others are abnormally susceptible to bichlorid of mercury—and develop a most unpleasant eczema; the phenomenon is rare, but is occasionally observed. A colleague of mine told me that he once saw an eye lost from suppuration following an eczema which developed as the result of the use of iodoform after an operation for cataract. Personally I have so far never seen this sensitiveness to iodoform.

Hence, even if we are unable to achieve complete sterilization of the operative field in the eye, as the investigations in our clinic appear to show, we should nevertheless, in my opinion, make every effort to accomplish that end as nearly as possible, and to render any microbes that may have remained in the wound as nearly harmless as possible.

The first logical conclusion to be deduced from our investigation is that the lashes and eyebrows must be removed before an operation for cataract. The lashes should be cut off with the scissors and the eyebrows shaved. I have learned by many years' experience that the unpleasant results, such as itching as the hair grows in, do not, as I had at first feared, occur. On the other hand, it is at once noticeable in the case of such patients how much more easily and better the cleansing of the edges of the lids,

which is such an important procedure, can be performed, especially when the dressing is changed after the operation, because the secretion does not adhere to the eyelashes. Anyone who has carefully observed his cataract patients during the summer can not have failed to notice that many of them, especially peasants—who often cover themselves up to the chin in spite of the heat—and obese individuals, sweat so profusely that the perspiration rolls down over the forehead. It is evident, therefore, that from the regions of the eyebrows, which in many cases can not be cleansed without shaving, microbes may be carried down to the palpebral fissure by the perspiration and may from there reach the conjunctival sac, especially if the eye is not bandaged. This is another reason for applying a bandage with a cotton pad during the first days after the operation, even when the eyebrows have been shaved.

Trimming the eyelashes and shaving the eyebrows before operations for cataract is not nearly as universal a proceeding as it ought to be. On the other hand, forcible epilation of all the cilia before the operation, as recommended by Hjort, is, in my estimation, too heroic a procedure. It is a cruel practice and not only unnecessary, but even injurious, owing to the irritation of the palpebral margins which follows. If for some reason there is an objection to cutting off the cilia, they should at least be freed from the germs with a cotton pledget dipped in benzine, a procedure which, according to von Pflugk, renders them free from germs.

Before every operation for cataract and before other operations, at least when suspicious symptoms such as epiphora, conjunctivitis, and blepharitis are present, the lachrymal passages should be tested not only to determine whether they are patulous, but whether they are normal as well. In some cases fluid that is injected through the lower canaliculus flows freely from the nasal orifice on the corresponding side, but the fluid is turbid from catarrh of the lachrymal sac or the lachrymonasal duct. In order

to determine whether the injected fluid, which should be a bichlorid-of-mercury solution of 1 : 5000, is turbid or not, it is best to collect it in a clean black receptacle, as, for example, one made of hard rubber. In this way the faintest suspicion of cloudiness can be detected. I consider this a very important point. If the fluid is not clear, the lachrymal apparatus should first be treated for a time with irrigation, using preferably a freshly prepared 1–2 per cent. protargol solution, which is to be injected once a day for several days. [For this purpose a 20 per cent. solution of argyrol is most efficient.—Ed.]

It is needless to say that the syringe—which ought always to be of glass—must be carefully sterilized before it is used for these diagnostic or prophylactic injections. The sterilizing is done by placing the glass syringe, with the canula, in a bichlorid solution of 1 : 1000 for a few minutes, or by boiling. If the patient is sensitive, a few drops of a 2–5 per cent. solution of cocain are injected into the lachrymal sac as a preliminary measure. The lower canaliculus, which is a little wider and more conveniently situated, is for obvious reasons selected for making the injections; it must be somewhat dilated with a conical probe, to facilitate the introduction of the delicate Anel syringe. Both the probe and the syringe are introduced into the canaliculus at first vertically and then horizontally, as the canal at first runs vertically from the lachrymal punctum; unless this precaution is observed, there is danger of making a false passage. The entire procedure must be executed with a light hand and with great caution. At the same time the operator should observe how the patient reacts to the interference, as it will guide his actions later during the operation. If the patient takes the injection quietly, it is most probable that he will be equally quiet during the operation.

If marked or complete stenosis of the lachrymonasal duct be discovered, the condition may be treated by introducing the probe or by extirpating the lachrymal sac if it is secreting. The latter procedure is absolutely necessary

if there is much secretion. If the catarrh is slight, it is not absolutely necessary to extirpate the sac, a procedure to which patients are very apt to refuse their consent. It may be treated for from three to five days with injections of protargol [or argyrol—Ed.], and finally with a 1 : 1000 bichlorid solution, after which the canaliculi are temporarily closed. This procedure, which I have practised for the past fifteen years, and recommended in 1891, I have so far found uniformly successful; it is also employed by Snellen, who speaks of it in his recently published *Operationslehre*. The galvanocautery is compressed to form a point and introduced a few millimeters into the upper and lower canaliculus, and the current closed. The latter need be strong enough only to produce a faint red heat. The effect of this cauterization is to cause temporary adhesion of the canaliculi, which prevents any secretion that may be present in the lachrymal sac from entering the conjunctiva. If any subsequent treatment is to be employed, the canaliculus can be reopened with a conical probe. When one of the canaliculi has already been slit, I nevertheless cauterize it as well as possible and introduce one of my iodoform pencils. I may say in support of this procedure that I have so far never seen any case, in which an operation for cataract had to be performed in the presence of an existing dacryostenosis, give trouble during its subsequent course. It is true that I always make it a practice in these cases to fill the inner canthus with iodoform.

In 1890 Eversbusch advised ligation of the canaliculi with catgut to render them impervious. [Ligation of the canaliculi is also advised by Buller, and represents an excellent practice in suitable cases.—Ed.]

The edges of the eyelids, in my estimation, may be as great a source of danger as the lachrymal sac, especially when they are inflamed. It is true that they do not come in direct contact with cataract wounds nor with the iridectomy wound in glaucoma, if the customary upper incision is employed, and the surgeon avoids using the lower

lid to turn out the remains of the cataract. Nevertheless the investigations of Bernheim, as I have already stated, have shown the importance from a prognostic point of view of the relation existing between the palpebral margins and the conjunctival sac—for micro-organisms readily make their way from the lids to the conjunctiva and may, of course, very easily spread between the lids and the bulb.

It is therefore most advisable to pay the closest attention to the palpebral margins in preparing the eye for operation, especially for cataract, and our present antiseptic and aseptic methods are anything but satisfactory when applied to these structures. The possibility of cleansing the palpebral margins with ichthyol will be referred to again in connection with the postoperative treatment of cataract.

In order to guard as much as possible against failures, rigorous precautions must be adopted to avoid pollution of the operative field during and after the operation. In this respect the following rules should be observed:

1. As in performing iridectomy and operations for cataract it is usually necessary to talk in order to give the patient directions or to quiet him, or even to scold him when he loses his self-control, it is not too much to say that the operation for cataract is the one which of all operations performed on man most requires precaution against *salivary infection*, especially as the operation is very often performed on people who are old and hard-of-hearing. For this reason the wearing of a mouth-bandage or mouth-mask is distinctly indicated in these operations.

For years before I adopted the mouth-bandage I was in the habit of having a plate of glass held above the operative field, especially when I was operating before students and wished to make explanatory remarks; but the mouth-bandage is more convenient.

[The following interesting facts in this connection are quoted from an editorial in the *Journal of the American Medical Association:* "It has long been recognized that saliva is an extremely dangerous medium of infection,

but it has remained for de Leon to demonstrate just how frequently it may be responsible for the instances of so-called unavoidable surgical infection. From a long series of careful and well-controlled experiments, he has obtained some very striking results. It was found that on the average about two hundred words were spoken by the operator alone in an ordinary operation. On an average, in each drop of saliva occur 4375 bacteria, and in the duration of an average operation 250,000 organisms may gain direct entrance to the wound. Among these, virulent organisms are constantly present, streptococci, diplococci, and staphylococci, in order of their frequency. To avoid this source of contamination, de Leon devised a simple *mouth-mask* which is efficacious and not burdensome and does not interfere with distinct articulation. Some bacteria were found to penetrate a gauze mouth-covering, though the number was materially reduced. If experience has shown that wounds are usually capable of withstanding a large number of bacteria, it has also demonstrated that under suitable conditions a few bacteria may give rise to serious and even fatal infection. Surgeons who have good personal technic and equally careful assistants should consider this fruitful source of infection, particularly where teaching makes more continuous and louder talking a necessity."—Ed.]

2. In handling the instruments immediately before and after the operation great care is necessary to avoid bringing them in contact with any unclean object. This precaution is particularly important as regards knives and needles which are to be introduced within the eye. It has long been a matter of experience, and the accident still occurs, although less frequently than formerly, that an operation of this kind, especially for cataract or one of a secondary nature, is followed by an intense purulent infection or a subacute inflammation, although no cause for the accident can be found. The catastrophy falls like "a bolt from the blue," and not only the affected eye is

ruined, but the health of the other eye is also endangered, and sometimes blindness results.

Fig. 1 shows how an infection of this kind may take place. The method of holding the cataract knife or cataract needle which is shown in the picture, and which is to be absolutely condemned, is one that the operator is quite likely to be guilty of if he finds something to correct in the position of the eye speculum at the beginning of the operation ; as, for example, drawing the lids further apart. When the instrument is held in this way, the point is very apt to come in contact with some object outside of the sterile field and become polluted without the surgeon becoming aware of the fact. I myself once had this experience—that is, I touched something with the instrument and fortunately felt it. It called my attention to the danger of handling instruments in this careless way. The surgeon should break himself of the bad habit of holding any cutting or pointed instrument in this faulty manner, which probably has its origin in the dissecting room.

3. In order to guard as much as possible against such pollution of the instruments the entire area surrounding the operative field should be covered with sterile gauze, leaving only the eye exposed (see Plates 2, 4, 7). The gauze is first wrung out of a 1 : 1000 bichlorid solution, to make it adhere to the skin.

4. There is no doubt that infection may also be caused by the use of imperfectly sterilized drops introduced into the eye before or after the operation. It is needless to say that any fluid used as a collyrium must be carefully sterilized before being used. This is best accomplished by boiling, because the addition of bichlorid of mercury (boric acid is absolutely useless) injures the solution, especially pilocarpin, and produces unnecessary irritation in many eyes. It is also important to make sure that the sterilized solutions remain free from germs by having them boiled again from time to time; for there is no doubt that secondary pollution of sterilized collyria not

infrequently takes place. Sidler-Huguenin succeeded in finding microbes quite frequently in solutions that we had used for some time, and these microbes consisted not only of sarcinæ and mold fungi, but also of streptococci and staphylococci which were found to be pathogenic. [Some years ago Dr. E. A. de Schweinitz and the editor made an elaborate bacteriologic examination of the pipets and collyria taken from a treatment case which had been used in ophthalmic practice for some time, and found in the fluids the micrococcus aquatilis, the bacillus liquefaciens, the proteus vulgaris, the micrococcus prodigeosus, the bacillus implexus, and aspergillus glaucus, as well as staphylococci and streptococci. The proteus vulgaris, the micrococcus prodigeosus, and the bacillus implexus obtained from these solutions introduced into the anterior chamber of rabbits produced a violent inflammation of the iris and anterior portion of the eye. Inoculations with the other organisms, except staphylococci and streptococci, were negative.—Ed.] It is therefore absolutely necessary that the solutions used at an operation have been recently boiled, and during the postoperative treatment it is also necessary to use sterile solutions. This is not such a simple matter as it would seem. It necessitates, first of all, properly working dropping bottles that can be boiled with their contents and in which there is not much danger of a subsequent pollution of the contents. Stroschein, Snellen, and others have busied themselves considerably with the improvement of dropping bottles. As Stroschein's bottle did not suit us altogether, Sidler-Huguenin devised one which presents certain additional improvements, the most important of which is the extra width of the mouth, so that in putting the pipet back in the bottle there is less danger of striking the point against the lip or even the outside of the bottle, an accident that is apt to happen with any dropping bottle hitherto devised. As the outside of the bottle cannot be kept absolutely clean while it is in use, it is always possible that the point of the pipet may be polluted by

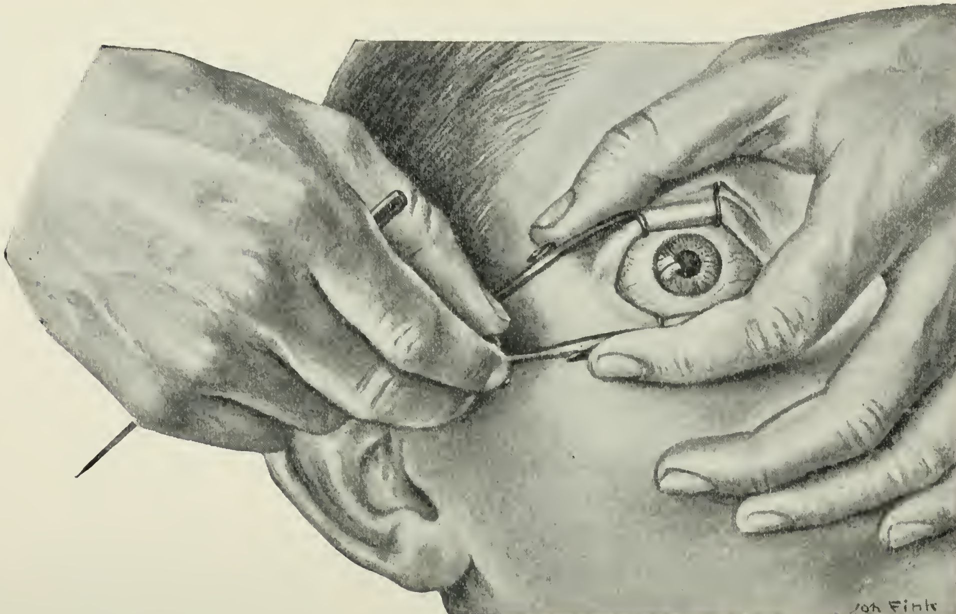

FIG. 1.—This illustration shows how cutting and pointed instruments should *not* be handled.

coming in contact with it and may thus contaminate the solution, so that the latter very soon ceases to be free from germs.

It should also be impossible for the contents of the pipet to get up into the bulb when the former is accidentally reversed, as very often happens with the attendants, and is very difficult to prevent. This requisite is also fully satisfied by Sidler's dropping bottle. The bulb is provided with a spiral tube (see Fig. 2), so that the fluid can not get up into it from the dropper, no matter how often it is held upside down.

FIG. 2.—Sidler's dropping bottle.

These bottles may be sterilized, a large number at a time, with steam, as, for example, in Budenberg's apparatus; or the bottle may be placed over a flame, with a piece of wire screen to prevent cracking, and used for boiling the contained solution. In either case a small glass rod is placed between the bottle and the pipet to prevent the latter from acting as a stopper.

It is not well to boil our alkaloid solution too often. In the case of cocain the following points, which have been determined by the careful investigations of Sidler-Huguenin, must be borne in mind: A cocain solution of more than 1 per cent., if sterilized several times for twenty minutes with steam, loses part of its anesthetic action, and a greater number of drops are therefore required to produce the same effect. On the other hand, when a 3 per cent. solution of cocain is boiled for a short time, even if the procedure is repeated several times, the anesthetizing strength is not impaired. A weak solution is injured more by boiling than is a strong one. As we do not possess any antiseptic suitable for addition to our

eye solutions in all cases, a practitioner will do well to keep an alcoholic stock solution on hand and prepare small quantities of cocain and atropin solutions as he needs them, while in hospitals, and whenever larger quantities are used, watery solutions are preferable; but they must be sterilized at regular intervals. [The best plan is to have all solutions used in eye operations prepared and properly sterilized immediately before the operations, and not again use these solutions in subsequent operations.—Ed.]

5. To make absolutely sure that accidental infection of the operative field has not taken place through sponges, gauze, dressing materials, sterilized water or sterilized salt solution, the surgeon must see to it that all these objects are really sterilized. It is to be remembered that sponges, gauze, and cotton for dressings, while they may be rendered sterile as regards pathogenic micro-organisms by one hours' exposure to steam not under pressure, will not be sterile as regards tetanus spores and the spores of *subtilis*, which are only killed by a short exposure to steam under pressure at 140° C. (284° F.).

Water and saline solutions may be regarded as free from active pathogenic microbes after boiling for one-half hour. To render them absolutely free from germs, including the spores referred to above, requires several hours' boiling. This is also true of intruments, which are freed only from the pathogenic germs by the degree of boiling to which they are customarily subjected (see Brunner).

The edge and point of an instrument suffer less when the boiling is done in a porcelain vessel, with or without the addition of soda. (For this information I am indebted to Mr. Weiss, a London instrument-maker.) It is better not to put the instruments into the fluid until after the air has been driven off by boiling. [The blades of sharp instruments should be wrapped in absorbent cotton before they are boiled; this lessens the danger of causing their points and edges to become dull.—Ed.]

The most satisfactory method of sterilizing gauze, sponges, and the cotton used in the dressing, is to put them into a moderately large tin drum with wire ends which can be closed, after the sterilization is completed, with a tin cover that has also been sterilized, and disinfect them in a large sterilizer which can be warmed afterward, so as to dry the materials out thoroughly. If the operator is not quite certain that the water or saline solution which is used for cleansing the conjunctival sac and keeping the wound clean, as well as that in which the instruments are placed, has been properly sterilized, he will do better to use a 1 : 5000 solution of bichlorid of mercury for the eye, and a 3 per cent. solution of carbolic acid for the instruments, unless it is desired to use them dry after they have been boiled. The operator can always determine quite readily whether the fluid contains bichlorid of mercury or carbolic acid, as the former substance is recognized by its taste and the latter by its smell. He can not, however, tell whether water is really sterile, and has no means of being sure that he has not been given unsterilized water by mistake.

In this connection Schirmer relates a most important personal experience, which shows how easily a mistake may occur in these matters. After he had operated on a large number of cataract cases—about 200—extending over a period of years, and the subsequent course had been practically normal in all, a change suddenly took place. In every seventh case, and later even more frequently (in 30 per cent. of the cases), extraction of the cataract was followed in from five to twelve days by an iridocyclitis with small deposits on Descemet's membrane. He observed this same complication after an iridectomy and after a discission. It is true that all the cases, after appropiate treatment, eventually ended in recovery with a good visual acuity; but convalescence lasted from two to three weeks, and in 4 cases in which there had been a recurrence of the inflammation from two to three months of treatment were required. Schirmer had performed all these operations by the aseptic method, using antiseptics only for the hands and for the cleansing of the galley pots, and a 3 per cent. boric-acid solution for moistening his cotton sponges, which had been sterilized with steam. By a mistake of the attendant this boric-acid solution had not been prepared according to directions. He had measured out the correct quantity of boric acid, dissolved it in boiling water, and then merely diluted it to the proper strength with ordinary well water, neglecting to boil the

entire solution. As soon as this error in technic had been corrected, Schirmer had no more cases of iritis.

In connection with the question of infection I must not neglect to state an important principle which must be kept in mind during operations. It is a principle that is not always properly respected, especially by beginners, and may be stated thus: Operations involving the opening of the capsule by incision or puncture should not, if at all possible, be performed at short intervals on the same eye; but only after the eye has become entirely free from any symptoms of inflammation, or even of mere irritation (as evidenced by lacrimation and ciliary redness). Any fresh operative intervention affecting the iris and ciliary body is particularly dangerous and very apt to produce sympathetic disease of the other eye, especially if the operation involves an incision at the corneal margin —that is, in the neighborhood of the ciliary body, and particularly when the vitreous comes in contact with the operative wound. Special caution in this respect is necessary in those cases in which the eye after an unsuccessful operation for cataract is to be put into better condition, or in cases in which the effects of traumatism are to be corrected before the eye has recovered from the original operative procedure.

The reasons for this will require for their elucidation a good deal of further investigation. One factor is obvious —namely, that in any injured or operated eye requiring a bandage, the germs frequently multiply in the course of time underneath the bandage; for when the eye has been bandaged for some time, catarrh of the conjunctiva and a slight degree of blepharitis are apt to develop, and conjunctivitis and blepharitis are always liable to increase the number of the germs in the conjunctival sac. If another operation is performed on the eye while it is in this condition, the danger of infection to the anterior chamber is very great.

It is also probable that the operative field often suffers a certain degree of pollution from pathogenic micro-

organisms during the first operation, the effects of which, however, gradually disappear without any great danger resulting, because the tissues of the interior of the eye—the anterior chamber and adjoining portions—gradually dispose of the parasites. Sometimes they are probably first covered with exudate or leukocytes and then become more or less encapsulated and are thus rendered harmless. If this course of healing is disturbed by a second operative intervention, the inflammatory process may be suddenly lighted up again and become more severe than before.

Exceptions to the important rule not to multiply operations in the same eye are found in the following cases:

1. If the lens has been injured, either purposely or accidentally (by trauma), and increased tension occurs as the result of traumatic cataract, puncture becomes necessary and may have to be repeated if the tension of the eye again becomes abnormally high.

2. After an iridectomy for glaucoma, if the effect has not been sufficiently marked, a second iridectomy or, better, a sclerotomy, must be performed. The latter operation may even be repeated whenever it seems necessary.

3. If an operation for cataract is followed by a normal recovery without any inflammation, so that the eye clears up at the end of two weeks, discission may be performed on the secondary cataract, but with the utmost caution. In most cases, however, it is well to wait from four to six weeks before performing a second operation.

4. After the entrance into the interior of the eye of a foreign body consisting of iron, if it is found impossible to remove it with a small magnet, an attempt to extract it with a large magnet may nevertheless be made as soon as possible.

Disinfection.

Having considered the various precautionary and other preliminary measures with which the eye must be pro-

tected in ophthalmic operations in order to prevent the entrance into the wound of the living causes of inflammation, which are ever ready to invade the wound and may become the cause of serious mischief, it will now be in order to consider what is the best thing to be done if, in spite of every care and precaution, the wound nevertheless becomes infected. At the same time we shall learn how accidental wounds of the eye—that is, wounds due to injury, which have become infected—are to be treated.

While the general surgeon, when confronted with infected wounds, as a rule has the advantage of being able to adopt fairly vigorous disinfecting measures in the tissues with which he has to deal (aside from the intracranial space and a few other localities), the delicate structure of the tissues of the eye—particularly of the cornea, where the greatest care is necessary to avoid causing an opacity—will not permit the use of vigorous measures for disinfection. The oculist, in a sense, has his hands tied, and so far as the sight is concerned, at least, it would be useless to free the eye from infection at the cost of the transparency of the refracting media—the cornea, lens, and vitreous.

When the anterior chamber has become the seat of infection, vigorous irrigation with disinfecting solutions is a measure that naturally suggests itself. Infection of the anterior chamber is recognized by the occurrence of iritis, either of a purulent character or merely with fibrinous exudate or deposits on Descemet's membrane. As early as the year 1878, when I attempted to apply Lister's system to the eye, I convinced myself by extensive investigations, chiefly on animals, that carbolic acid in the strength of 3 per cent., which is the minimum of efficiency, is not tolerated by the anterior chamber and particularly by the cornea. The cornea becomes opaque as the result of destruction of the endothelium of Descemet's membrane by the disinfectant. The opacity of the cornea is most intense and permanent if the action of the carbolic

acid is severe enough to destroy Descemet's membrane. This fact was later confirmed as regards bichlorid of mercury by unfortunate, accidental experiences with human subjects.

Alfr. Gräfe found, to his sorrow, that occasionally, if during and after an operation for cataract he irrigated the operative field copiously with a slightly warmed 2 per cent. solution of bichlorid of mercury, an intense and persistent opacity of the cornea developed which might require weeks to clear up and in some cases never disappeared. Preliminary cocainization of the eye evidently tends to reinforce the effect of the bichlorid. The effect of cocain is, on the one hand, to increase the absorbtive power of the cornea and, on the other hand, greatly to facilitate the entrance of the irrigating fluid into the anterior chamber. For, when the eye has been thoroughly cocainized before an operation for cataract, the intra-ocular tension is greatly reduced, often before the delivery of the lens, but particularly after the lens has been removed, and especially in rigid, senile eyes. Even before the era of cocain a marked depression of the cornea with or without the entrance of air into the anterior chamber had occasionally been observed at the end of operation in eyes of this kind. Cocain analgesia increases this condition of marked diminution of intra-ocular tension by rendering the operation painless, and therefore preventing the contraction of the external eye muscles which compress the globe. Hence, if the capsule is rigid, intra-ocular tension is considerably diminished, and not only air and blood, but irrigating fluid also, may be aspirated into the anterior chamber. If a large quantity of the latter fluid enters the anterior chamber, the endothelium of Descemet's membrane and ultimately the membrane itself may be injured. Thus Alfr. Gräfe saw 6 out of 150 cataract patients leave his clinic with a corneal opacity so that they could not see much better after the operation than before (Bunge). Hence, we can not use the strong fluid disinfectants to cleanse the anterior chamber. On the other hand, flushing out the chamber merely with an indifferent fluid, such, for example, as physiologic salt solution, is in most cases inadequate, nor is mere evacuation of the contents of the anterior chamber through a corneal puncture, even if it be repeated, sufficient to prevent infection.

Having introduced iodoform into the eye in about 50 cases I may say, as a result of my observations in these cases, that the drug is probably the best we now have for intra-ocular disinfection. Although it is undeniable that in many cases in which the infection is very virulent or has spread extensively in the interior of the eye, the remedy fails, it is nevertheless true that in many cases the results obtained are good or at least fair. Similar ob-

servations have been made in other clinics. The hope I expressed in my first paper on iodoform disinfection—that it might protect the other eye against sympathetic inflammation—has, however, unfortunately not been realized.

Iodoform should be introduced into the anterior chamber or into the vitreous in the form of a thick pencil from 5 to 7 mm. in length. If the wound, either operative or traumatic, is a large one, small discs may be used, the convex side of which may be applied to a curved incision without introducing any air into the wound, as, for example, in the case of a cataract wound.

The pencils and discs must be prepared in such a way as to pulverize readily when they come in contact with a fluid, the iodoform being thus enabled to spread out over a considerable area in the anterior chamber or in the vitreous. In this way its disinfecting power is enhanced. At the same time the pencils, especially the thinner ones, must be hard enough to be readily introduced through a small wound. The desired degree of hardness may be obtained by adding a small quantity of sterilized-gelatin solution and subjecting the mass to a great pressure, the iodoform gelatin paste being pressed through the point of a metal syringe provided with a screw piston; the caliber of the syringe at the point must be equal to 1 mm. The thread of iodoform is received on a sterilized glass plate and cut up into pencils with oblique ends, to facilitate their introduction into wounds.

The preparation of the iodoform pencils and discs which I use and recommend has been accurately described by Dr. Sidler-Huguenin, who has so far exclusively attended to their preparation; for it is obvious that every precaution must be observed in the preparation of this material. J. Bernheim demonstrated by certain investigations carried out in our laboratory that iodoform may be polluted with microbes, and with pathogenic microbes at that. Sidler-Huguenin, who has frequently washed iodoform out in a 3 per cent. solution of carbolic acid, often found unorganized particles of matter, splinters of wood and the like, which would be capable of causing irritation in the interior of the eye. As the number of microbes that we have to combat is always an important feature in disinfection, their number must not be still more increased by the introduction of the iodoform into the interior of the eye. For this reason the iodoform preparations must be sterile and must be kept sterile. In removing them from the glass tubes in which they are put up by the trade,[1] a sterilized forceps should be used, which must be absolutely dry, else the pencils will break up as soon as they are within the grasp of the forceps.

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[1] This is done by the Apotheke zur Post, Kreuzplatz, Zurich V.

Plate 1.

Introduction of a pencil of iodoform into the anterior chamber in a case of infection by a foreign body.

The iodoform pencils may be introduced either through the already existing wound or through an incision. One pencil is usually enough for the anterior chamber; but under certain circumstances it may be advisable to introduce two or three into the vitreous, depending on the extent of the infectious inflammation.

The method of introducing the pencil into the anterior chamber is shown in Plate 1, illustrating a case in which, after the removal of a spicule of iron with the aid of my large magnet, signs of infection developed, with the accumulation of pus in the anterior chamber. As in this case the wound from which the foreign body had been extracted was already closed, an incision was made into the temporal half of the cornea with a Gräfe cataract-knife, and the pencil, which was held with a curved iridectomy forceps with serrated jaws, rapidly introduced through this incision. It is important to see that no aqueous humor escapes during the incision. The accident can easily be avoided if the eye is well cocainized and the knife is sharp. The introduction should be effected rapidly, to guard against premature melting of the iodoform pencil. Finally, in order to prevent the pencil from slipping out of the anterior chamber, great care must be taken to see that it is introduced rapidly and that all of it enters the chamber. This is best accomplished by first introducing it as far as possible with the forceps, then releasing it for a moment and pushing it in the rest of the way with the closed forceps, which is therefore used like a delicate probe. In this way the freely movable pencil can be properly placed in the anterior chamber. If there already is a large wound in the cornea or in the sclera, the jaws of the introducing forceps should not be released until the pencil is completely within the anterior chamber or vitreous body.

The incision should be no larger than absolutely necessary, but it should not be too small—that is to say, for pencils 1 mm. in diameter the incision should be made with a narrow Gräfe knife, and not with a keratome, because with the former instrument the internal wound (in Descemet's membrane) can be made as large as the external wound, and the wound canal in the cornea therefore does not become narrow as it approaches the anterior chamber. Another advantage of the narrow Gräfe knife is that it is better adapted for puncturing and cutting than the keratome. The same considerations obtain for incision of the sclera. If that procedure becomes necessary, the coat must first be properly exposed by incising the conjunctiva and Tenon's capsule so that the subsequent incision of the membrane may remain constantly exposed to view. If the conjunctiva and sclera are incised at the same time, the rapid introduction of the pencil may be impossible because the sclera wound may be missed.

That iodoform is well borne by the anterior chamber I learned from my earliest experiences in the year 1892, when I treated tuberculosis of the iris and suspicious cases of tuberculous iritis with deposits by the introduction of iodoform pencils. From that it was a natural step to employ the remedy against a purulent infection, because I had always considered iodoform a useful antiseptic and had used it in the treatment of the wound after a cataract operation. It is, however, to be observed that when there is intense infectious inflammation in the anterior chamber, a fairly heavy opacity sometimes develops in the cornea at the point where the iodoform is placed, and it occasionally happens that the corneal opacity does not disappear altogether. It is therefore advisable not to place the iodoform immediately in front of the pupil, whenever that can be avoided. It appears that the toxins generated by the inflammatory process, acting together with the iodoform, are capable of injuring the endothelium of Descemet's membrane. Nevertheless, in eyes that have gradually become free from inflammation, remains of iodoform may be seen even on the lens without producing any opacity.

The iodoform is gradually removed from the anterior chamber by absorption, and I have often seen it remain there without producing any irritation after the inflamma-

tion (for the removal of which its use was necessary) had long ago disappeared.

Iodoform is also well tolerated by the vitreous body, from which it also gradually disappears. Disinfection of the vitreous, however, may obviously be a most difficult task, as the germs may spread over such a large area that they can not be reached and controlled with iodoform. In disinfecting with iodoform, as with any other disinfectant, the generally familiar observation is made that the sooner disinfection is begun, and the milder the infectious process, the more probably will our efforts at disinfection be crowned with success. The virulence of the infectious process depends not only on the relation between the activity of the microbes on the one hand, and that of the tissue attacked on the other, but also on the kind of germs that are present. It appears that in the case of certain varieties of bacilli, which are extremely pathogenic for the eye, and which most frequently effect an entrance along with splinters from a hoe, are too virulent for iodoform disinfection, and in these cases the method is apt to prove futile. I named these organisms *panophthalmia bacilli* and they were later recognized by Silberschmidt and Römer as belonging to the group of *hay bacilli*. The method may, of course, prove a failure with other microbes, especially if the drug is not brought into sufficiently close contact with the germs, or the latter can not for some reason be brought sufficiently within its influence. Thus, even Descemet's membrane is sufficient to prevent a purulent ulcer of the cornea from being adequately influenced by iodoform introduced into the anterior chamber, and for this reason the treatment of *ulcus serpens* by introducing iodoform into the anterior chamber is not a suitable one.

Iodoform acts slowly and, therefore, does not injure the tissues with which it comes in contact, and if it can be confined within a narrow space along with the pathogenic germs that have entered the eye, and the tissues are enabled to develop their normal power of resistance, the

attempt to render the microbes innocuous may be successful; for it is not necessary to kill the germs, if only they are prevented from multiplying.

That is why intra-ocular disinfection with iodoform quite often yields very favorable results if the method is adopted early and carried out properly. On the other hand, it is practically incapable of doing any harm, so far as my experience has gone.

This method of treating the interior of the eye with iodoform is specially adapted for the treatment of infected traumatic or operative wounds that have penetrated deep into the eye, as, for example, wounds due to the entrance of foreign bodies or any large pointed or cutting objects. It can also be used to advantage after cataract operations that do not heal kindly, especially if an insidious iridocyclitis with deposits persists for some time and keeps the eye from quieting down. I have observed very favorable results in scars that have suppurated after operation, and which have become very angry.

Superficial wounds that show signs of infection may also be disinfected by means of heat, either with the galvanic-electric platinum loop or Pacquelin's benzin cautery. If the effect of heat is desired in the depth of the wound, the latter method alone is to be recommended, because, when the galvanic-electric loop is introduced into a moist tissue, the current is short-circuited by the moisture of the tissues and the loop at once begins to cool. When Pacquelin's cautery is used for the eye, it should be fitted with a specially fine point. Disinfection by cauterization is always attended by the disadvantage that the dead tissue may become the seat of further bacterial growth. There is also danger, if the cauterization in the deeper portions of the eye is thorough, that the destruction may be so great as to cause marked cicatricial contraction and retinal detachment. [The editor can substantiate the author's statements in regard to iodoform under the circumstances detailed. Opening of the wound and daily drainage of the anterior chamber is, according to Knapp, the most efficient

method of combatting infections of the eye after cataract extraction. For certain infections, limited to the anterior portion of the eye, and unassociated with the formation of ring abscess in the cornea, but with fibrinous exudate in the anterior chamber, dionin in 5 per cent. solution has an excellent effect; the same is true of a 25 per cent. solution of argyrol.—ED.]

Instruments.

A few remarks about instruments may not come amiss. It is evident that operations on such an important organ as the eye call for instruments which must be of the very best make and in absolutely perfect condition. The success of an ophthalmic operation is often entirely dependent on the excellence and proper construction of the instruments used. Above all, the cutting and puncturing instruments with which the capsule of the bulb is opened—that is, cataract knives, needles, capsule knives, discission needles, and the like, must be as perfect, with regard to their edges and points, as it is possible to make them. For this reason an instrument of this kind can not be used any length of time, no matter how careful the operator may be, without being reground.

The cornea and sclera are tough and hard to cut; hence, only properly constructed and properly sharpened instruments are capable of making a smooth incision. The smoother the incision, the more easily and the more quickly will union of the wound and healing take place. When the edges of the wound are bruised and torn they are covered with partially or totally contused and dead particles of tissue which must first be cast off or absorbed before healing can take place. Such tissue elements, which have been destroyed by the incision, are also quite capable of becoming culture media for pathogenic micro-organisms. The sooner union and healing take place in the wound, the better is the prospect of preventing the growth of bacteria, in other words, secondary wound in-

fection. Secondary—*i. e.*, post-operative—infection is a special danger in wounds of the eye because the operative field can not be rendered or maintained absolutely sterile. For this reason a smooth incision, made with a sharp instrument, and with as little contusion of the edges of the wound as possible, is a strong guarantee of a smooth recovery. Properly constructed instruments and proper care in keeping them in order are, therefore, two important factors influencing the result of operations on the eye.

A good polish is very important for knives, needles, and scissors. In the first place it has much to do with the smoothness of the incision and the absence of contusion of the wound edges. In the second place, an instrument that is perfectly polished is less apt to become soiled, and is much more easily cleansed; and for this reason all instruments, whether cutting or non-cutting (strabismus hooks, spatulas, specula, and the like), should always be as smooth and bright as possible. Good polish and smooth finish are strong guarantees of asepsis. It has been proved that a well-polished instrument may be rendered germ free or nearly so by simple mechanical rubbing. If, in addition, the precaution is taken to see that an instrument is never very badly soiled by allowing shreds of tissue from the wound to adhere to the blade, I find by years of experience that knives, keratomes, discission needles and the like can be disinfected or kept aseptic with the least degree of injury to the cutting edge by placing them for ten minutes in a 3 per cent. solution of carbolic acid and rubbing them well with sterile gauze or cotton while in the solution. In the twenty-five years that I have used this method in my private institution I have never had a single case of primary wound-infection after an operation for cataract, and altogether only 1 case of suppuration, which began on the fifth day after operation, and could, therefore, hardly have been caused by the instrument.

If it is desired to boil cutting and puncturing instru-

ments, great care must be taken to guard both edge and polish against injury. Boiling for ten minutes in a 1 per cent. solution of sodium carbonate renders them sterile, at least as regards the ordinary pathogenic germs. The coating of soda which adheres to the instruments after boiling and spoils the polish must be removed at once, and this is best effected by transferring the instruments, or the vessel containing them, from the boiling water into sterilized water or sterilized salt solution. Great caution must be observed, however, to see that the sterilized fluids really are sterile.

Instruments with ivory handles may also be boiled; but after a time the ivory deteriorates and becomes rough, so that perfectly smooth handles made of metal and well nickel-plated are to be preferred. The cross-pieces with which some instrument makers provide the metal handles are undesirable and, in fact, useless.

In a large clinic service there is no doubt that the most convenient and safest method of sterilizing that has yet been devised is by boiling at least all non-cutting instruments; and treating cutting and puncturing instruments with the previously mentioned precautions.

Keeping the instruments constantly moist during the operation, by returning them to a sterilized fluid every time they are used, has the great advantage that it prevents pieces of tissue adhering and renders them easier to cleanse. The cleansing should be done soon after the operation, because, if the instruments are left in the fluid any length of time, both the polish and the edge suffer. It was formerly customary, when necessary to use two instruments in rapid succession, as, for example, the cystotome and a curet, to attach them to the same handle; and this is still sometimes done (Fig. 29). But it is not to be recommended, nor is it necessary, since we know that rapidity during the operation is not an important factor. The danger is that in using such an instrument the end which is turned away from the eye—for example, the curet-end—may be soiled by coming in contact with some other object while the cystotome is being used, for it

is impossible to watch both ends of an instrument and at the same time the entire operative field.

An instrumentarium for operations on the eye which shall contain the most necessary instruments is composed as follows:

2 Desmarres' eye specula,
1 Spring speculum after Bowman, Snowden, etc.,
1 Desmarres' lid clamp or entropion forceps,
2 Knapp or Snellen lid clamps,
1 Jäger horn spatula,
1 Cilia forceps,
1 Fixation forceps, with catch,
1 Fixation forceps, without catch,
1 Curved fixation forceps,
1 Heavy straight fixation forceps,
1 Fine straight conjunctival forceps,
1 Curved iris forceps, with hooks,
1 Curved and serated iris forceps,
1 Heavy curved Cooper scissors,
1 Large heavy scissors,
1 Small straight sharp-pointed scissors,
1 Curved strabismus scissors, with blunt ends,
1 Curved sharp iridectomy scissors,
1 Wecker's scissors,
5 Gräfe's cataract-knives,
5 Keratomes of various widths,
2 Bowman discission needles,
2 Knapp's capsule knives,
3 Large and small scalpels,
1 Weber's knife for splitting the canaliculi, straight,
1 Weber's knife for splitting the canaliculi, curved,
1 Gräfe's cystotome,
1 Schweigger's cystotome,
1 Daviel lens-scoop,
1 Hard-rubber or glass scoop for delivering the cataract,
1 Critchett's scoop,
1 Broad wire loop, after Weber,
1 Narrow wire loop, after Snellen,

1 German silver spatula for replacing the iris,
2 Strabismus hooks, large and small,
1 Double Wecker hook or Prince forceps (angular), for muscle advancement,
2 Large double hooks,
2 Small double hooks,
1 Single small hook,
1 Pointed iris hook,
1 Blunt iris hook,
6 Péan or Langenbeck hemostats,
12 Best curved needles, large and small,
1 Needle-holder,
1 Myrtle-leaf probe,
4 Bowman's lacrimal probes,
1 Conical probe,
2 Glass syringes.

The possession of the following instruments is also desirable:

Desmarres' capsule forceps,
1 Couching needle,
1 Beer cataract-knife,
1 Straight cataract-knife (Beer),
1 Blunt Desmarres' knife,
Knapp's curved knife-needles (curet-hook),
Lang's knives for separating anterior synechiæ,
Pellier's eye speculum,
Müller's retractors for extirpating the lacrimal sac.

Instrumentarium for Krönlein's operation:
Galvanocautery and large moist cell,
Pacquelin's thermocautery,
Giant magnet,
Small magnet,
Illuminating apparatus for the removal of foreign bodies from the cornea, after Sidler-Huguenin.

OPERATIONS ON THE EYE.

(A) OPERATIONS ON THE GLOBE.

1. OPERATION FOR CATARACT.

THE removal of an opaque lens is one of the most important and most difficult tasks that falls to the lot of the ophthalmic surgeon; for in this operation, more than in any other, the eye is exposed to the danger of infection and therefore to rapid, purulent inflammation or slow and insidious cyclitis, which may even eventually cause blindness of the other eye. The operation for cataract, especially for senile cataract, therefore furnishes a touchstone for the ophthalmic surgeon's efficiency, both as to his operative technic and the prevention of surgical complications.

As cataract is much more common in later life than in youth, so-called senile cataract forms the largest and most important group. It should be mentioned, however, that age merely constitutes a predisposing factor and that the true cause of cataract, so far as it is known at all, lies in disease and weakness of the entire body, or of important organs, or of the eye itself.

The division into *juvenile* and *senile* cataract was suggested by operative considerations. Up to the age of thirty the lens is uniformly soft; after that period, however, the central fibers of the lens, owing to the physiologic hardening of the tissues, contract, and a hard nucleus is formed, which in the course of years constantly increases in size and hardness. As this nucleus grows, the soft cortex naturally diminishes more and more, and by the sixtieth year of life the sclerosis has usually spread to the capsule of the lens.

Physiologic sclerosis (the cause of diminution of the power of accommodation and presbyopia) has nothing directly to do with the formation of cataract; but it is an

important factor in the cataractous process because the hardened nucleus for the most part resists the degeneration which involves the rest of the cataract and, forming a solid body, plays an important part at the operation. When, on the other hand, as is the case in the juvenile eye, no nucleus has been formed, the entire lens, as it softens, is converted into a semifluid mass which does not contain a hard nucleus.

Sometimes clouding of the nucleus is prevented by the same process of sclerosis, and after the cataract has matured a fairly clear nucleus, which, as a rule, has a yellowish color, is found surrounded by the grayish, absolutely opaque and glue-like cortical substance. In such a case we have to deal with a *senile, cortical cataract*. The development of cortical cataract begins with the appearance in the cortex of striæ and rows of punctate opacities, which gradually increase in number and radiate toward the center, followed by the appearance of gray wedges, while the nucleus retains its transparency for some time. As the process goes on, the nucleus may also lose some of its transparency, but the haziness chiefly affects the cortex.

Sometimes, but on the whole less frequently, the cataract begins in the nucleus and immediately contiguous surrounding zone of cortex. In such a case we speak of *nuclear cataract*. The haziness of the cortex in these cases varies both as regards intensity and rapidity of development. It sometimes happens that complete opacity does not develop until the individual has reached an advanced age, although the sclerosis gradually becomes more firm.

In nuclear cataract the visual disturbance appears earlier and is more intense than is the case in cortical cataract; unless the latter begins with an anterior or posterior polar opacity, and not, as is usually the case, at the equator of the lens.

The term *capsular cataract*, finally, is applied to opacities formed by proliferation of the epithelial cells in the

capsule of the lens. The entire posterior aspect of the anterior lens capsule is covered by a single layer of capsular epithelium. In cataract formation this epithelium, as a rule, begins to proliferate at the center, opposite the anterior pole; but not until the cataract has existed for some time and has become over-ripe; so that anterior capsular cataract is an important sign of "over-ripeness" of the cataract. These proliferations of capsular epithelium are recognized by the white color in contrast to the opaque cortex, which is more gray or grayish white, and by the fact that they form at the anterior pole a circular or irregular patch which gradually increases in size and often appears as a distinct thickening on the cortical opacity.

In those cases in which cataract is produced by some grave disease of the eye—*complicated cataract*—anterior capsular cataract is sometimes found, as, for example, when cyclitis or retinal detachment has been followed by profound disorganization of the eye, with cataract. *Anterior polar* or *pyramidal cataract*, which occurs in earlier life as a result of ulcerative perforation of the cornea, is another form of capsular cataract.

It follows from what has been said that the lens varies in accordance with age, and that the structure of the cataract and its condition greatly influences the surgeon in his choice of operative procedures for its removal. There are various methods of removing the lens from the eye.

1. We require with lenses, which as yet have no firm nucleus, simply to open the anterior capsule, and then to leave the absorption of their entire contents to the eye alone. During this process the lenticular masses, which may be perfectly clear or more or less completely opaque, gradually enter the anterior chamber and are there absorbed. The process of absorption may, if necessary, be shortened by puncturing the anterior chamber and thus evacuating the semifluid lenticular masses. If the lens is completely opaque at the time the capsule is

opened—as, for example, as the result of total congenital cataract or cataract developing early in life—absorption may take place without anything further. If, on the other hand, the lens is only partially opaque when the capsule is opened, as, for example, in lamellar or zonular cataract, the non-opaque cortical and nuclear masses must first become cataractous by imbibition of aqueous humor, which causes them to swell and protrude into the anterior chamber, where they then undergo absorption. If the lens shows no haziness whatever when the capsule is opened, as, for example, in stab-wounds or in the operation for myopia, the entire lenticular mass, before it can be absorbed or evacuated by puncture, must be gradually saturated and distended with aqueous humor, so as to become cataractous and disintegrate.

The above-described method of removing the lens therefore implies the following requisites:

(*a*) Good absorbing power in the eye, which is greatest in youth and diminishes with advancing age.

(*b*) Little tendency to increased tension (glaucoma), which, as we know, is an almost certain result of traumatic cataract. The tendency to glaucoma is less in youth than in old age.

(*c*) The lens must be one that does not contain a hard nucleus, because the latter could not readily be absorbed in the anterior chamber, but would cause irritation and under the most favorable circumstances would require a long time to undergo absorption.

Simple laceration or discission of the anterior capsule, with or without subsequent puncture of the anterior chamber, is therefore applicable only to young eyes up to the age of thirty to thirty-five—*i. e.*, before any marked nucleus formation has taken place, and it makes no difference how great the haziness of the lens at the time of operation; for the hazier, the more readily it will be removed from the eye, either by simple absorption or with the aid of puncture of the anterior chamber, as the evacuation brought about by that procedure is the more com-

plete, the greater the capacity and consequently the disintegration of the lens.

2. It is obvious from the foregoing that when there is marked nucleus formation—that is, after the thirtieth to the thirty-fifth year of life—a different method must be adopted for the removal of the cataract. Assuming that the conditions for cataract operation are present, we must turn our thoughts as much as possible to the nucleus; and we will not succeed any longer, after the capsule has been opened, with mere puncture of the anterior chamber—that is, with an incision from 3 to 5 mm. in length—but need a cataract incision so large that this nucleus can readily escape. This incision need not be so large in patients of thirty-five to forty-five years as at a later period of life.

Indications.—As with advancing years the absorptive power of the eye diminishes and the tendency to glaucoma increases, the indications for operation are also subject to variation. It is important to reduce to a minimum the cataractous masses to be absorbed after a cataract operation, if rapid recovery is desired. Whenever it is possible, the *entire contents* of the capsule must be removed at the operation. If we proceed properly the nucleus is readily expelled; but the same can not be said of the cortex, parts of which often adhere to the capsule, especially when it is not opaque. In such a case the cortical substance becomes hazy after the operation, through the entrance into it of aqueous humor, and has to be absorbed by the eye. These cortical remains often interfere for a long time with vision. They sometimes encroach upon and irritate the iris, and—most important of all—conjure up the danger of glaucoma.

1. For this reason it is always best in cases of cataract during the later decades of life to wait for complete opacity of the cortex—**maturity of the cataract**—before operating; in other words, until the conditions are such that the cortical substance, having undergone total cataractous disintegration, separates completely from the cap-

sule after the anterior capsule is opened and slips out of the wound, either bringing the nucleus with it or following immediately after the nucleus which slips out ahead.

It is not always altogether easy to determine whether a cataract is ripe in this sense. In the great majority of senile cataracts conditions are such that, as soon as the third stage has been reached, operation gives the best prospect of speedy success.

By the first stage is meant the beginning of cataract, *cataracta incipiens;* the second stage is that of swelling, because as the cloudiness increases the lens begins to swell, as may be determined by noting the diminution in the depth of the anterior chamber. During the second stage the cloudiness of the cortical substance is still incomplete, and on examination with lateral illumination an interval can be made out between the lenticular cloudiness and the edge of the pupil, the latter throwing a faint shadow on the cloudy lens, which is situated some little distance behind it.

During the third stage, that of operative maturity, the cloudiness of the lens has extended to the capsule and therefore as far as the pupillary margin, so that the shadow of the latter is no longer seen. At the same time the swelling of the cloudy lens diminishes during this stage and the original depth of the anterior chamber is restored.

During the fourth stage, that of over-ripeness, the cataract is seen gradually to contract; the depth of the anterior chamber is therefore still further increased, the radiating striation disappears on account of the continued disintegration of the cortex and is replaced by the pale, dotted appearance of capsulary cataract which begins in the middle, at the anterior pole. Eventually the cortex may liquefy and allow the nucleus to sink to the bottom of the resulting fluid. This is known as a *Morgagnian cataract* and is not a very common occurrence. In most cases the cataract contracts to form a flat tenacious disc, which does not separate so readily from the capsule as is the case during the third stage. During the stage of over-ripeness a process begins which is of grave import from the operative standpoint; the suspensory ligament of the lens, zonule of Zinn, atrophies, and tremulousness of the over-ripe cataract results—that is, the cataract trembles with every movement of the eye. Or the friable character of the zonule in an over-ripe cataract of this kind may not be recognized until it tears during the operation and allows the vitreous to enter the wound.

It follows, therefore, that over-ripeness of the cataract diminishes the favorable conditions for a formal operation for cataract and a smooth recovery.

Although the stage of maturity is the best for operation, the surgeon is often compelled to operate before this desirable condition is present because the patient wishes

to recover his sight as soon as possible in order to guard against any accident that might arise on account of his defective vision. It is especially when cataract develops in the remaining useful eye that an early operation of this kind may be absolutely demanded. Premature operation may also become necessary when both cataracts develop at the same time and with equal intensity, although in most cases of double cataract the development is unequal and the process progresses more rapidly in one eye than in the other. Fortunately, in some cases the immaturity, which at first arouses serious anxiety in the surgeon, is only apparent—that is to say, although some portions of the cortex have not become hazy, the result of the cataract operation is nevertheless a favorable one.

(*a*) It occasionally happens, mostly in the case of old persons, that the haziness of the cortex is very slightly or not at all pronounced. The cataract is a dull-yellow or brownish color, or the pupillary region may appear perfectly black—black cataract (*cataracta nigra*). When the eyes are examined with the ophthalmoscope, however, it is found that the transparency of the lens is greatly impaired and the eyeground can only be seen very indistinctly. The darker the pupil appears with lateral illumination, the darker and more blurred will be the veiled background of the eye. As a rule, eyes of this kind possess better vision than those with the ordinary gray cataract. A lens with the latter variety of cataract transmits the rays of light better in both directions than is the case in the former variety of cataract, so that, on the one hand, the examiner is able to see the eyeground with some degree of accuracy, and the patient, on the other hand, retains the power of recognizing larger objects. Nevertheless, the impairment of vision is usually sufficient to cause a serious disability and menace to the patient.

It would be very bad practice to wait for the development of gray discoloration of the anterior cortex and blindness before operating on cataracts of this kind. These lenses never become gray or entirely opaque like

other lenses, because they have no cortex to become gray. The lenticular sclerosis in these cases extends as far as the capsule, either prematurely or at the normal time—that is, after the sixtieth year—and this hardening change protects the lenticular mass from disintegrating into a gray, semifluid material, just as in the case of the physiologic hardening process of senility which prevents disintegration, so that the cataractous lens always contains a nucleus which may vary in size. The size of the nucleus must determine the size of the incision necessary for its escape at the operation. To be exact, the condition in these cases is not a cataract formation, but merely a hardening. When an eye of this kind is operated upon, the opening of the capsule is immediately followed by the escape of the entire contents *in toto* in the form of a large, hard, amber colored or brown cataract; and if the wound has not been made large enough the delivery of the cataract may cause great difficulties. After the escape of the cataract the pupillary region may be perfectly clean and without a trace of opacity. A cataract of this kind is, therefore, mature or operable even before it has become entirely opaque and gray.

(*b*) Occasionaly in individuals who are not very old and in cases of myopia there may be an incomplete haziness of the lens, made up of a number of striæ, usually radiating toward the center, and narrow wedges interspersed with dots and small patches, chiefly affecting the cortical portion. But the nucleus also frequently presents delicate punctate and striate opacities. The patients see as through a screen and vision is usually imperfect, and although they are still able to find their way, they are in danger of occasionally breaking a limb. Sometimes they are still able to read coarse print, and on examination with the ophthalmoscope the eyeground can still be seen indistinctly.

This variety of cataract is also operable if the opaque striæ, dots, and patches extend all the way to the capsule of the lens; for in that case the cortex comes away almost completely from the capsule at the operation. It is

possible for some of the cortex to remain behind; but, as a rule, it would be useless in these cases to wait for complete haziness of the lens to develop.

(*c*) There is another group of cataracts susceptible of operation, although the cortex is only partially and insufficiently cloudy. They are the cases of cataract in which the hardening process of age comes to our aid, that is, cataracts occurring after the sixtieth year, in which the cortex also is involved in the sclerosis and has, therefore, attained a consistency which enables it to escape from the capsules without adhering to it. As a matter of fact, most lenses might be extracted without any more ado after the sixtieth year, depending only on the degree of hardening. It has been found, however, that the cataractous process often spoils our calculations by interfering with the normal hardening of the cortex and, therefore, with its separation from the capsule. The cortex remains semitransparent and does not undergo cataractous degeneration; nor does it harden properly, or at least the hardening is only partial, and when cataracts of this kind are extracted, a considerable portion of the cortex often remains behind. In spite of this fact, however, the period of disability is less than it would be if operation were deferred until perfect maturity, which in these cases often occurs very late, even though it may take weeks or even months before the patient regains his eyesight.

Although it is always a serious matter to leave remains of the cortex behind when operating on cataract in old persons, the danger in this respect has nevertheless been diminished by the adoption of antiseptic and aseptic methods. For my part I am convinced that if we can succeed in protecting the wound from inflammation, in other words, keep it aseptic, the eye will tolerate a considerable quantity of cataractous material that has been left behind, and the latter will eventually be absorbed, providing the eye is kept under careful supervision and the pupillary action, as well as any changes in pressure, can be controlled with suitable drugs. On the other hand, if

the anterior chamber has become infected in the operation, even if the infection is not a very virulent one, the situation at once becomes much more dangerons in the presence of any cataractous remains, because the latter afford a good culture medium for the infectious germs.

The modern treatment of wounds has rendered the outlook in operations on unripe cataracts much more favorable.

Attempts to render unripe cataracts operable by artificial maturation have been in vogue for some time. At one time this was done by making one or several small, preparatory discissions or punctures in the anterior capsule, because it is a matter of common observation that slight injuries of the lens, as, for example, by a foreign body, may gradually produce complete traumatic cataract.

The procedure, however, fell into disrepute, and there is no doubt that it was formerly a dangerous one, and often followed by an undesirable degree of irritation, glaucoma, or even grave inflammation. It has been again recommended in more recent times, and perhaps this is another illustration of asepsis rendering possible a procedure which before its advent was proscribed; but so far I have had no personal experience in this matter.

A much more harmless method of inducing maturity artificially is that suggested by Foerster. He advises massage of the cataract, after a preliminary iridectomy, using a suitable blunt instrument, such as a strabismus hook or curet, with which the center of the cornea is to be rubbed, and asserts that the procedure is followed in a few days by the development of complete opacity. The method is suitable in many cases and quite worthy of commendation, but I have often found that in slowly maturing cataracts this massage of the lens fails to hasten the development of opacity sufficiently. [More effectual than Foerster's method of artificially ripening cataract is paracentesis of the cornea and internal massage directly on the anterior capsule of the lens with a small spatula, a method which Knapp, following the recommendations of

Ricaldi and Bettmann, has recently advocated. Simple paracentesis of the cornea with external massage, as recommended by T. R. Pooley and J. R. White, is said to be effectual. Should cortical remnants be found after the extraction of unripe cataract, they may be removed with the help of a syringe, as has been specially recommended by McKeown, Lippincott, and others. The editor has not, however, been pleased with this form of irrigation, although in the hands of experienced colleagues it finds much favor. He believes that the lens may be safely extracted even if it is in part unclouded, certainly after the sixtieth year, and prefers extracting an unripe cataract to performing a ripening operation.—Ed.] Snellen, Horner, and others long ago emphasized the fact that an iridectomy usually hastens the ripening of a cataract and that this is, therefore, one of the most important reasons for resorting to *preliminary iridectomy*—that is, an iridectomy performed a few weeks before extraction of the cataract. It also increases the chances of success by the fact that a major operation is divided into two minor operations, each of which is less dangerous by itself. Another consideration is that the preliminary operation has a desirable educational effect on the patient and enables the operator to determine how he acts under the knife, information which he will find useful to guide him at the subsequent extraction. The preliminary operation is also the best one to combat any disposition there may be to glaucoma, which sometimes develops in a most unpleasant way after a cataract extraction, even when no part of the cataract has been left behind.

Preliminary iridectomy is unquestionably most desirable in many cases and is especially indicated when complications threaten, either during or after the operation, aside from insufficient ripeness—be it that the eye is not entirely normal, as, for example, in high myopia, or the patient's strength and general condition necessitate the greatest caution. A preliminary iridectomy is also, as a rule, necessary in cases of true complicated cataract—

that is, cases in which there has been iritis, choroiditis, and disease of the vitreous.

As in all these cases a secondary operation for cataract is usually necessary, it is true that three operations in all have to be performed. But why, when so much is at stake, should not this course be pursued, even if it be somewhat slower, since it offers greater security and freedom from risk, particularly as each of the three operations necessitates only a short period in bed and is practically painless.

The *diagnosis* of maturity—that is, the condition in which the lens is suitable for operation—is evidently not a simple matter and, as we have seen, depends on other factors besides clouding of the anterior cortex. Complete opacity of the lens is also more difficult to recognize positively because it is impossible to make sure that the posterior cortex has undergone cataractous disintegration and will separate readily from the capsule. It is true that in most cases the condition of the posterior cortex, as regards the degree of opacity, is the same as that of the anterior cortex, but there are exceptions. Thus, it may happen that after the extraction of a cataract which seems to be entirely opaque, the operator is surprised to find that a good deal of the cataractous material has remained behind. It has also happened when the anterior cortex presented Foerster's maturity that the posterior was not in the same condition.

In addition to careful inspection of the lens with the aid of a magnifying glass after dilatation of the pupil,[1] and the other factors already mentioned, such as the depth of the anterior chamber, the change in the shadow of the iris, etc., the functional state of the eye affords some information as to the degree of ripeness. But from

[1] I wish to emphasize particularly a caution which ought not need to be mentioned. It is that atropin must never be used under these circumstances to dilate the pupil, because cataractous eyes, aside from their age, are naturally prone to develop glaucoma, especially while the cataract is swelling; for this reason homatropin [or euphthalmin—Ed.] should always be preferred.

what has already been said it would evidently be wrong to judge of the operability of a cataract solely by the condition of the eyesight and to wait until the affected eye becomes totally blind.

2. **Function.**—Among the conditions affecting the success of the operation must be mentioned, in addition to ripeness of the cataract, the functional condition of the affected eye—that is to say, the health of the eye—especially as regards the deeper portions which escape inspection in advanced stages of cataract, and are, therefore, judged only by investigating the function. A case of cataract can not be regarded as operable unless the eye still possesses a certain degree of vision, at least for movements of the hands at 0.25 to 0.05 m.; it is impossible to give accurate numbers.

Whether the retina still retains some *central vision* may be roughly determined by noting whether the patient is still able to perceive movements of the hands or the flame of a candle in the dark at a distance of 6 m. The latter test, however, in the case of cataract includes much more than the center of the retina, because an opaque lens acts much like a piece of ground glass held before the eye, which diffuses the light from the candle over the entire retina, so that the flame can be perceived even when a central scotoma is present. [The function of the center of the retina should be tested by means of two small flames, which under normal conditions should be readily recognized as such by the patient.—Ed.] However, the candle-test also reveals the light sense of the retina and is useful on that account.

The degree of *peripheral vision* is determined by means of the so-called *projection-test*, a kind of measuring of the visual field by means of a coarse stimulus capable of affecting the cornea through the cataract. The patient is taken into a dark room, the other eye is bandaged, and his ability to localize with the cataractous eye a candle flame in various portions of the visual field is tested, the examiner covering the patient's eye with his hand while

the light is being placed at the desired spot—above, below, to the right, to the left, etc. As soon as the eye is uncovered the patient should be able to point to the light with his finger at once and unerringly. With unintelligent patients this test must be repeated, if it is unsatisfactory the first time, until the patient learns what is expected of him. Many patients also believe that they will not be operated upon unless they have lost their vision completely and therefore give incorrect answers in order to be sent home without operation. The projection-test enables us to determine whether the retina is the seat of a gross lesion, such as detachment, occlusion of its vessels, etc.; or if, for example, a tumor of the choroid is present.

The function of the retina and of the optic nerve is further determined by testing the *pupillary reaction*, which incidentally shows whether any synechiæ are present. Although the latter do not render the operation impossible, they diminish the chances for success because they are often associated with disease of the vitreous.

As it is impossible in most cases, if the cataract is complete before the patient is seen, to find out whether the posterior segment of the eye is in good condition—as it ought to be if the cataract operation is to be successful—it is very important that the practising physician who recognizes, or at least suspects, beginning cataract should send his patient at once to the oculist who is to operate later on, so as to enable the latter to satisfy himself that the lens is still tolerably transparent, that the eye is sound, and, in short, to enable him to get better acquainted with the eye. This is often of the utmost value.

I wish to state emphatically, however, that it is both inhuman and unwise for either a general practitioner or a specialist to mention cataract and operation to a patient before the cataract has reached the stage when an operation will soon be required; for nobody likes to be told that he has a cataract (our excellent statistics notwithstanding), and most people are greatly alarmed by the information. Besides, if the individual is very old and

dies before operation becomes necessary, the physician will have embittered his declining days unnecessarily by the premature announcement. In the same way it is bad practice to mention the question of operation until it has been definitely determined that the cataract can be successfully extracted.

3. **Bodily (General) Condition of the Patient.**—Another important condition for a successful operation is that the general bodily condition of the patient be satisfactory. Extreme age is no contra-indication to a cataract operation if the patient's strength is fairly good, although patients and their friends usually think otherwise. Idiocy, minor degrees of epilepsy, and deaf-mutism do not contra-indicate the operation; on the contrary, those afflicted with the latter misfortune should be operated upon as early as possible, and are usually most grateful for the improvement in their general condition thus brought about.

The operation is not rendered impossible by diabetes and albuminuria, unless the diseases mentioned are far advanced; but under such circumstances special caution is required and the diet must be suitably regulated in some cases for some time before the operation.

On the other hand, *suppurating processes* of any kind in the body—leg ulcers, eczema, and the like—must be regarded as strict contra-indications so long as they are present. If they can not be cured, the diseased portion must at least be rendered innocuous by covering it with an antiseptic bandage during the entire time the eyes are under treatment. It is absolutely indispensable to surround the eye with special care before and after the operation in such cases.

The conditions for a cataract operation, so far as the eye itself is concerned, can be deduced in part from what has been said and in part will be discussed in connection with methods of operation.

If both eyes are the seat of cataracts that have reached maturity, it is not advisable to operate on both cataracts

at the same time, because if any unfortunate complication, such as wound-infection during the operation, delirium tremens, diphtheria or erysipelas should ensue, both eyes might be lost. It is better to defer operation on the second eye until after the wound in the first has healed, and, in the case of old persons, until after the patient has completely recovered from the first operation.

Is it proper to operate on an eye with a ripe cataract when vision is perfectly good in the other eye? The answer to this question is that it is proper to remove cataract of this kind only when it has become completely ripe and is in no danger of becoming over-ripe. Under such circumstances, however, the patient often exhibits very little gratitude for having obtained vision with his cataractous eye, and occasionally he even complains that the vision of the operated eye disturbs that of the sound eye. It is therefore well to explain the state of the case to him carefully beforehand and to tell him that the eye which is to be operated upon will only be used to a moderate degree, and, in a sense, represents a reserve eye in case the other should at any time become blind from cataract. He should be told that he really would not need cataract glasses after recovery; but practically it is better to give him cataract glasses nevertheless, in order to enable him to convince himself that he can see with the eye; otherwise he will think the operation has been unsuccessful.

The important and often difficult question, when may or shall a cataract be operated upon before it is ripe has been largely answered in the foregoing pages. It may be well, however, to recapitulate. There is no doubt that nowadays, thanks to the improvement in the treatment of wounds, we need not hesitate as much as formerly to operate on unripe cataracts when it is necessary. It would not be right to adhere to the former practice, which at that time was perfectly justifiable, to make patients wait, sometimes until they depart for a better world, for complete ripening of the cataract and operation. It must

always be clearly kept in mind that an operation on a cataract which is actually—not only apparently—unripe involves certain dangers, the least of which is a tedious recovery. The last-mentioned fact must be clearly placed before anyone with a cataract of this kind, and it must be explained to him beforehand that a secondary operation will probably have to be performed. If in the end it turns out that the latter is unnecessary, it is all the better.

My experience has not taught me that cataract, whether completely or only partially opaque, can be extraced with the same success after the sixtieth year of life. When the opacity of the cataract is incomplete, it often requires weeks or even months for the remains to be absorbed. It is true that even in these cases vision may eventually be quite good; a question that will be referred to later.

When shall an operation for cataract be preceded by an iridectomy?

This question, which will be touched upon again in the course of this work, may be answered in a general way by saying that on general principles iridectomy is to be avoided in operating on cataract and is to be resorted to only when there are strong reasons for doing so.

It will probably be generally conceded at the present time that in all cases of juvenile cataract, including the lamellar form, and in all cases up to the fortieth or forty-fifth year of life, especially in female patients, iridectomy can in almost every instance be avoided and must be avoided. Even if the tension increases while a cataract of this kind is under treatment, iridectomy is not always necessary at this age; for the increased tension may be corrected by corneal puncture or possibly by a sclerotomy.

At this time of life the question of appearance must be considered by the operator, because at this age the eyes are generally held wide open, while in old persons, owing to the loss of fat in the orbit, the upper lid usually hangs down over and, as a rule, covers the upper half of the cornea, so that one has to raise the eyelid with the finger

in old people to find out whether an iridectomy has been performed.

Another reason why iridectomy is less urgent in earlier life, up to the age of forty or forty-five, is that the nucleus of the cataract is not so large; hence its delivery is easier and not so severe on the iris, as is the case later on.

Opinions differ as to whether in the case of true senile cataract the operation should or should not be preceded by iridectomy. It may be remarked in general that, although an operator may on principle avoid iridectomy, he will nevertheless be compelled from time to time to resort to the operation, and that it is better to do so whenever the iris is at all slow to return to the anterior chamber after the delivery of the cataract, and there is corresponding failure of the pupil to contract. It is impossible to know beforehand how the iris will act. Individuals differ in this respect, and it has often been observed that if the iris returns readily in one eye it will do the same in the other if the latter is operated upon later; and, conversely, if the iris shows flaccidity in the first eye, it will do the same thing in the second eye. It is not advisable to bring about contraction of the pupil beforehand by instilling physostigmin, because the contraction of the pupil may interfere with the ready escape of the cataract, with the result that a good deal of cortical matter is stripped off and remains behind the iris.

In the case of old and feeble persons who must not be kept in bed for any length of time, because they would lose their appetite altogether and might develop hypostatic pneumonia from the continued recumbent posture, it is more advisable, as a rule, to excise the iris, for by doing so it is quite possible to allow the patient to get up and walk about twenty-four hours after the operation, without the danger of prolapse of the iris.

In another class of patients, who, for other reasons, such as, for example, occasional severe attacks of coughing or sneezing, great nervous excitement, nervous distress on account of heart trouble and the like, are not

likely to keep quiet for twenty-four to forty-eight hours, it is advisable to perform an iridectomy before extracting the cataract. In many cases of this kind and whenever a complication before or after the operation is imminent, such, for example, as an escape of vitreous by reason of the patient's unmanageableness or idiocy, abnormal conditions of the eye—such as liquefaction of the vitreous from myopia and the like—it is always well to have a preliminary iridectomy.

In weighing the reasons for and against iridectomy in operations for senile cataract it should be mentioned that it is of no importance whatever, so far as the patient's ultimate visual power is concerned, whether the pupil remains round or not. In either case vision may be normal or practically normal, provided the pupillary region is free from the remains of cataract. Owing to this necessity of keeping the pupillary region absolutely clear, secondary cataract operations are somewhat more frequently required after the simple one, that is, one without iridectomy, than after an operation combined with iridectomy, because the remains of the cataract can be better stripped out in the latter case than when the iris remains intact and therefore hinders the escape of the soft cortical masses. This is not a very important factor, however, because secondary operations have to be resorted to often enough after combined extraction if the operator hopes to secure perfect vision.

It has been objected to by those who advocate the simple operation that the increased amount of light admitted to the eye, as the result of the iridectomy, may be a disturbing factor. It is to be remarked, however, that in the case of old persons the upper lid generally covers the iridectomy and prevents the light from entering through the coloboma. On the other hand, when the upper lid does not hang so low, as, for example, when the eyes are somewhat more prominent, it is quite true that the iridectomy-gap is not screened against the excess of light, and that an increased amount of light enters the

eye and may blind the patient and cause him to see red—*erythropsia.* The latter phenomenon is due to the fact that when an eye, particularly one that is deprived of its lens, is exposed to strong light for some time, the retina gets into a condition of excessive irritation; and when the patient enters a dark place all bright objects for a time appear to be colored a bright red, which greatly frightens the patient and causes him to think that a hemorrhage has occurred. It appears from the investigations of Fuchs and others that the ultraviolet light rays are chiefly concerned in producing this effect on the retina and that they may cause erythropsia in the normal eye, as, for example, after a long period of snow-blindness on high mountains. As the lens has a high absorption for chemical light rays and keeps them away from the retina, eyes with aphakia are more liable to erythropsia than those which still possess a lens.

If, therefore, the upper part of the iris is not covered by the lid, it is better to leave the iris intact when operating for cataract.

It is not true, however, that simple cataract extraction without iridectomy is less dangerous and less apt to be followed by wound infection because the traumatism to the eye is somewhat less extensive.

First of all, the simple operation has the disadvantage that if, during the night after the operation or even later, the wound suddenly opens, the iris may be washed into the wound by the aqueous humor and a prolapse of the iris may thus be produced, causing distortion of the pupil upward and disfiguring the eye and interfering with the regular progress of recovery. It is anything but pleasant under such circumstances to be forced to operate again; for there is no choice and the prolapsed portion of the iris must be removed absolutely. This point will be referred to later.

On the other hand, it is possible, even when the operation for cataract is preceded by iridectomy and especially if the wound is slow to heal and frequently reopens, for

the iris to slip into the wound or to be washed into it by the aqueous humor. As a rule this happens only on one side of the coloboma. But the accident is not often observed and is usually mild in degree.

It will be well, on the whole, to decide this question of iridectomy chiefly by individual conditions and to avoid routine methods.

Under what circumstances may general anesthesia be employed for cataract operation?

In answering this question it is to be remembered that the eyeball is, as a rule, rotated upward during the anesthesia, especially if it is not very profound, and thus makes it difficult to place the incision at the upper border of the cornea, which is justly considered the preferable site. It is not always easy in general anesthesia to rotate the eyeball downward with the forceps without causing a dangerous gaping of the wound.

Another disadvantage of general anesthesia is the vomiting that frequently follows, as it is apt to interfere with closure of the wound, and in old persons with friable vessels may cause intra-ocular hemorrhage.

Finally, general anesthesia always implies a certain degree of danger to life.

Cataract operations, to begin with, are not very painful, and with the proper use of cocain can be rendered bearable even to the most sensitive patient, so that, for these reasons and the above considerations as well, general anesthesia should be practically abandoned in the case of old persons, and if employed at all should be reserved for patients who, on account of idiocy or absolute inability to control themselves, offer no guarantee that they will conduct themselves properly during the operation. In such cases it may be advisable to extract the cataract from below if the upward rotation of the eyes is very marked. In operating on children, chloroform is always necessary if, owing to great restlessness and excitement on the part of the little patient, it is impossible to perform the operation properly, and especially when there is danger of tear-

ing the zonule of Zinn and thus allowing the vitreous to enter the wound. In the case of very small children only a small quantity of chloroform is required to keep them quiet during the brief time occupied. It is often possible by speaking to the child kindly, and, especially if one has good assistants, to control the situation with cocain.

Having thus discussed in a general way the necessary conditions for a cataract operation and the preliminary examinations, I shall turn my attention to the operation itself as it is to be performed in the various forms of cataract, and shall incidentally discuss various special aspects of the question, including the after-treatment. Beginning with the simpler procedure which suffices for removing a cataract in the case of children, we proceed to discuss

(a) The Operation for the Removal of Total Juvenile Cataract.

By this term is meant a cataract which is noticed soon after birth or perhaps somewhat later, and is usually brought to the physician for treatment early because the gray color in the pupil is noticed by the patient's family. This form of cataract is usually bilateral and much more rare than senile cataract.

Juvenile cataract is especially amenable to treatment by simple *discission*, a method which, owing to its simplicity, can be used with little children. The indication is to remove these cataracts as early as possible, so as to enable the retina to receive distinct images as soon as the child begins to use its eyes, and thus prevent the development of the form of defective vision which has been attributed to failure to use the retina during the period of development (amblyopia exanopsia), and which may give rise to nystagmus—*i. e.*, irregular action of the eye-muscles—explainable on the assumption that the complicated mechanism of the ocular muscles is not properly regulated by the formation of distinct retinal images, and therefore fails to develop properly.

Nevertheless it is not advisable to operate on these cataracts too early—*i. e.*, before the end of the first or second year of life—because it sometimes happens that, owing to prolapse of the cataract into the anterior chamber, incision of the cornea and the removal of part of the cataractized masses become necessary after discission has been performed. This complicates the operative treatment and requires bandages and sometimes rest, measures that are difficult to carry out in the case of a very small child.

On the other hand, the operation must not be delayed too long, because otherwise a cataract of this kind becomes over-ripe, contracts, and then requires the same treatment as a senile, membranous cataract, which is similar to the treatment of dense secondary cataract (to be discussed later), and which may be attended with some difficulties.

Before beginning the operation, a careful examination must be made to determine whether the cataract is simple or complicated, and particularly whether there are any synechiæ—*i. e.*, traces of an antecedent or still active iritis. If there are synechiæ—which may not be distinctly visible until the pupil has been dilated with homotropin or atropin—the prognosis is dubious, because these are generally cases of congenital syphilis. This fact should be made clear to the family beforehand, for the reason that in this disease other alterations are often present in the deeper structures of the eye or may make their appearance after the operation and endanger the eyesight. On general principles it is wiser in the case of cataract in very small children, even when they are not complicated, to maintain a certain reserve in regard to the result of the operation. There are cases which never attain more than a moderate visual power, even when resulting successfully, a condition for which it is sometimes impossible to discover a cause.

The *preparations* for discission are simple. As the operative wound is a mere perforation and is therefore a comparatively trivial interference, the cleansing of the operative field need not be so rigorous. After the pupil

has been dilated with atropin and a few drops of a 3 per cent. solution of cocain have been introduced into the eye, the skin of the lids and surrounding portions is cleansed with soap and warm water, and then with bichlorid solution of 1 : 1000, after which the conjunctival sac is washed out with a bichlorid solution of 1 : 5000 or with sterile salt solution. The operation is usually performed without anesthesia. The speculum (Fig. 10), is introduced or an assistant holds the lids apart, the operator seizes the bulb with the fixation forceps (Fig. 21) at a point to the nasal side of the cornea, and with a discission needle (Fig. 56) or a capsule knife (Fig. 58) pierces the cornea at a point a little below the horizontal meridian and 3 mm. from the

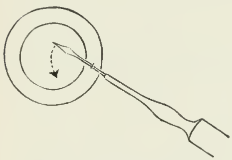

Fig. 3.—Division of the anterior capsule of the lens with Bowman's discission needle.

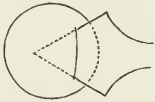

Fig. 4.—Linear incision through the cornea with the keratome.

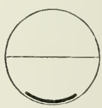

Fig. 5.—Flat curved incision.

temporal border of the membrane, carrying the instrument a little beyond the center of the pupil. [The needle may be entered just external to the limbus.—Ed.] After the lens has been entered, an opening is made with the point of the needle in the capsule of the lens, 4 to 5 mm. in length, and running from above downward (Fig. 3); the needle is then rotated about its long axis and at the same time slightly withdrawn, a short transverse incision is made, and, after the needle has been rotated back into its original position, it is quickly removed, so as to prevent the escape of any aqueous humor. A little cotton and a few strips of adhesive plaster are always necessary for a dressing, and during the first two days the child's arms must,

as a rule, be bound to its sides to prevent its handling the dressings.

The *after-treatment* consists in carefully looking after the dressing and keeping the pupil dilated by instilling from 1 to 2 drops of atropin solution per day. The eye must be kept under close supervision on account of the danger of increased tension, which would manifest itself by haziness of the surface of the cornea. If the child cries out and closes the eyes forcibly when an attempt is made to determine the intra-ocular tension by palpation, it must be brought slightly under the influence of an anesthetic. If the tension rises on account of prolapse of cataractous material the first thing to do is to diminish the atropin, and, if that fails to correct the trouble, an incision is made in the anterior chamber, under full anesthesia, if the child is unruly.

For this purpose a keratome instead of a needle is introduced into the anterior chamber in the same way as for discission. The instrument is best introduced in the temporal portion of the cornea, between the margin and the center, so as to make a vertical incision from 4 to 6 mm. in length, the extremities being at equal distances from the center of the cornea (Fig. 4). After the lens has been withdrawn, the periphery of the wound is depressed somewhat with the spatula (Fig. 30), so as to make the wound gape and cause the escape of the cataractous mass. If the latter is tough and slow to escape, the spatula is introduced a distance of 4 to 5 mm. into the anterior chamber and into the cataractous mass, the periphery of the wound is pushed back, and the spatula rotated around the long axis of its handle from one side to the other to stir up the cataractous masses. By the aid of this manouver it is possible to evacuate a considerable quantity of lenticular masses without doing any injury, even when they are quite tough. If necessary, the evacuation may be assisted by exerting moderate pressure on the globe at the same time with the fixation-forceps.

The anterior chamber may also be opened at the tem-

poral, lower, or upper border of the cornea instead of between the border and the center (Fig. 5). If during the evacuation of the cataract the iris is forced into the wound, the surgeon must take care not to leave it there, but must replace it with the aid of the spatula.

The operation of opening the anterior chamber by means of the incisions shown in Figs. 4 and 5 is also called *simple linear extraction*, but the term is not appropriate for most of these incisions. A true linear incision through the cornea must occupy the plane of one of its meridians—that is, a plane which passes through the center of the curvature of the cornea. Such an incision would necessitate introducing the keratome practically at a right angle and aiming directly at the said center of curvature. But such a method of introducing the lancet would endanger the posterior capsule of the lens. A linear incision might resemble the flat-curved incision shown in Fig. 4; the line shown in Fig. 5 passing transversely over the cornea would also represent a linear incision. As a rule, however, the keratome is introduced into the anterior chamber in such a way that the wound coincides with a parallel of the cornea, and therefore represents a flat incision or curved incision with variable degrees of convexity, as, for example, the incision at the lower border of the cornea shown in Fig. 5.

This method of removing portions of the cataract also requires great care to prevent rupture of the zonula or laceration of the posterior capsule and the escape of vitreous into the wound. This unfortunate accident may even follow primary incision if the operator is not careful to avoid lateral traction of the lens in performing the operation. If the vitreous appears in the corneal wound in the form of a transparent bead, the operation must be terminated at once and a dressing applied. If this is done, a small quantity of vitreous may return of its own accord.

After the cataract has been removed in this way a heavy dressing of cotton, adhesive-plaster strips, and a roller bandage, usually a double one, must be worn for two days. At the end of every twenty-four hours the surgeon must determine whether atropin is necessary to keep the pupil dilated, and how much is required. In children, who always try to rub their eyes, the eye that has been operated upon must be kept well bandaged for at least a week.

If the child is somewhat older and has the sense to submit to rest and the application of a bandage, the treatment by discission may be abandoned in favor of the senile linear extraction—*i. e.*, extraction of the cataract through an incision like those shown in Figs. 4 and 5.

Without previous dilatation of the pupil by atropin the eye is cocainized, the lids and surrounding skin cleansed with soap and bichlorid solution, and, after the conjunctival sac has been flushed out with a 1 : 5000 solution of bichlorid or with sterile salt solution, the stop-speculum is applied and the cornea at once opened by means of one or the other above-mentioned incisions. The keratome may also be introduced from above; but as a rule it will be found most convenient to introduce the instrument on the temporal side, as shown in Fig. 4, the globe being steadied by seizing the conjunctiva with the fixation-forceps near the corneal margin, at a point opposite the entrance to the wound, as shown in Plate 6. In carrying the keratome forward the point must always be directed toward the axis of the eye. The opening of the anterior capsule may be effected by introducing the keratome into the lens at once or, better, by withdrawing the instrument after the corneal incision, which should be 5 to 6 mm. in length, has been made, and afterward opening the capsule by a fairly liberal incision with a cystotome (Fig. 40), as will be more accurately described later in connection with operations on senile cataracts. In this procedure also great care must be exercised to avoid lateral dislocation of the lens, so as not to lacerate the zonule of Zinn. As a rule, the opening of the anterior capsule is at once followed by the escape of part of the cataract into the anterior chamber. The next step consists in evacuating the entire cataractous mass with the spatula, as has already been explained. Small remnants may be left to be absorbed. The after-treatment is the same as that of incision following discission.

(b) Operation for Total Soft Cataract of Adults.

The cataract is removed in the manner just described by means of a corneal incision ("simple linear extraction") whenever the age of the patient and the appearance of the cataract are such as to make it probable that the cataract does not contain a nucleus or a small one. The presence of a nucleus can sometimes be recognized under strong lateral illumination by the presence of a denser opacity in the central portion of the lens, particularly in patients over thirty-five years of age. If the presence of a nucleus is demonstrated, or the age of the patient is such as to render its presence probable, a curved, and correspondingly larger, incision is made at the edge of the cornea, either with a keratome or with a Gräfe cataract-knife. The operation is exactly like that for senile cataract without iridectomy, to which the reader is accordingly referred.

Soft cataracts in middle-aged patients, particularly in women, are sometimes complicated with iritic deposits on the posterior wall of the cornea, with synechiæ, and without the eye exhibiting any other disease—no redness or irritation. Such a condition is, according to my experience, no contra-indication to the operation. As a rule the deposits disappear after the operation.

(c) Operation for Traumatic Cataract.

Up to the age of thirty-five to forty years, the period when nucleus-formation begins to be marked, this operation is also performed according to the method described in the preceding paragraph—*i. e.*, the cataract is removed through a corneal incision of varying size.

If the anterior capsule has been opened by the injury and the wound has failed to close, causing the escape of cataractous masses, exactly as after a discission when the operation is performed on a lens that is not opaque or only partially so, nothing more is required except an incision to the anterior chamber. If, on the other hand, the anterior capsule has only sustained a slight injury and the wound has closed, a form of cataract in every respect

resembling ordinary spontaneous cataract may develop, and the operator will be forced to open the anterior capsule. The same thing often happens when a small foreign body perforates the lens completely or becomes embedded in the posterior capsule without injuring the structure.

When a splinter has passed completely through the lens, as not infrequently happens, total cataract, as a rule, develops sooner or later. In very rare instances—I have personally observed such a case—the lens remains clear. In operating on such a lens after it has become completely opaque, much greater care is required than in cases in which the posterior capsule is intact; for the wound of the posterior capsule, even though it may be small and may have existed for some time, so as to make it probable that cicatrization has taken place, is apt to re-open—according to my experience—and allow the vitreous to escape into the wound, thus bringing about a most undesirable complication. It seems that under certain circumstances the wound in the posterior capsule enlarges, and even when the original opening is small, the prolapse of vitreous may be quite considerable.

In order to minimize this danger it is advisable to keep the eye under the influence of cocain for some time before the operation—that is, to instill 1 drop of a 3 per cent. solution of cocain every five minutes for one-half hour, because the intra-ocular tension is thereby diminished. It is also advisable, as in every case when an escape of vitreous is to be feared, to tell the patient, during the operation, to keep his eye directed straight forward—that is, in the primary position, and to rotate it as little as possible to the side or upward, because rotation of the eye, by increasing the pressure of the external eye-muscles which are put on the stretch, causes an increase in the intra-ocular tension and brings with it the danger of escape of the vitreous. For this reason a cataract of this kind is best extracted through an incision in the temporal or lower half of the cornea.

In these cases there is also a special indication for the strict observance of every rule of antisepsis and asepsis before, during, and after the operation.

If a foreign body, after passing through the lens, becomes embedded in the back of the eye and can not be removed, and the eye remains free from inflammation, the removal of such a traumatic cataract is indicated in spite of the existing complication, not so much for the purpose of restoring the eyesight, as to avoid any evil consequences that a cataract of this kind may give rise to by becoming over-ripe (dislocation into the anterior chamber or into the vitreous).

It is to be remembered that by removing a cataract the eyesight may be restored to a considerable degree even when the splinter, which may be a particle of copper or of iron, remains embedded in the eye; and if the foreign body becomes well encysted, vision may be preserved for some years.

If, as rarely happens, a particle of copper or stone becomes embedded in the lens, it should be allowed to stay there if it is well tolerated until the lens has become completely opaque, when the foreign body is removed along with the cataract. But if the foreign body in the lens is of iron, it is better to extract it as soon as possible with the large magnet (see Magnet-operation) and to operate on the cataract later.

Traumatic cataract may also be produced by a severe blow on the eye lacerating the capsule of the lens. The laceration usually occurs in the equatorial region of the lens. This also, as a rule, leads to total cataract; at the same time, however, the neighboring zonule of Zinn is also torn. This complication, which has a very important bearing on the operation, is not always easy to recognize; but it may manifest itself by the appearance of a small portion of vitreous making its way from behind the iris into the pupil, which is often somewhat distorted, and this prolapse of the vitreous can be recognized under strong lateral illumination and, if necessary, with the aid

of a lens. The iris is forced away from the lens at the corresponding point. Laceration of the zonule of Zinn, when of considerable size, often manifests itself by slight tremor of the lens, which at the same time may be somewhat decentered—*i. e.*, displaced toward the side opposite the laceration. Finally, there are cases in which the iris is torn from its ciliary attachment before laceration of the zonule of Zinn takes place, so that the absence of the zonule can be seen directly through the black opening formed by the iridodialysis, it being impossible to see the fine radiating fibers of the structure, either with the ophthalmoscope or under lateral illumination with a magnifying lens.

Whether laceration of the zonule is diagnosticated or only surmised, the danger of prolapse of the vitreous, which infallibly forces its way into the corneal incision, must be kept constantly in mind when operating on a traumatic cataract produced by the violent impact of a blunt body. A cataract of this kind should therefore, whenever possible, be extracted by the operation of discission with two needles, without making any corneal incision. The discission wound in the capsule should be very small, so as to prevent the escape of a large quantity of lenticular material into the anterior chamber and the development of glaucoma. If, owing to the small size of the capsular opening, absorption is interrupted because the cells of capsular epithelium sometimes cover up the gap, a second or third discission through the same opening in the capsule may be cautiously performed to remedy the trouble. Although this method is slow, it is very much safer than any other and is to be recommended above all others in these cases.

Whether the cause of a traumatic cataract be one or the other of the above-mentioned factors, it may be partial and may never become total. If the partial cataract interferes with vision, as is sometimes the case, for example, when it forms a figure like a rosette at the posterior pole, and if the vision of the other eye is feeble and it

becomes necessary to restore the vision of the injured eye, the procedures to be described in the following section are to be adopted.

(d) Operation for Partial Stationary Cataract.

Partial cataract, which does not go on to complete clouding of the lens, is usually treated while the patient is still young.

Lamellar Cataract.—This is the most frequent and therefore the most important example of the class. It develops chiefly in children suffering from convulsions and rachitis and is almost always bilateral. The characteristic features are an anterior and posterior layer of opacity surrounding a nucleus of variable size, which is either clear or only slightly opaque. When the nucleus is large, the opaque layers are near the capsule of the lens; when it is small, the capsule is separated from the opaque portions by a broad layer of clear cortical matter. The opacity of the two layers, the edges of which may overlap like segments of a sphere, may be of a variable degree of intensity. When the opacity is only slight, the eye is not impervious to direct light and the individual's vision is only moderately reduced. There are cases in which the opacity is so slight as practically not to interfere with vision at all; in such cases we may speak of a rudimentary lamellar cataract. As a rule, however, the opacity is such as to impair the visual power, especially if the child is going to school and there is a considerable demand on the eyes; for this reason children with lamellar cataracts present themselves for treatment during the school years.

The best treatment, as a rule, consists in removal of the lens, because optic iridectomy, which will be mentioned later, frequently leaves the eye with incomplete vision, and the success of the procedure under certain circumstances may be diminished by the fact that later, as the patient becomes older, the cortical layer, which up to that

time had remained unaffected and which through the iridectomy becomes accessible to the rays of light that enter the eye, gradually becomes more and more opaque; although, as a rule, the opacity in this variety of cataract remains stationary until extreme old age and is limited to the zone between the nucleus and the cortex. Iridectomy, however, can only be performed in a comparatively small group of cases, in which the lamellar cataract is small enough to leave room for the rays of light to enter the eye after the iridectomy has been performed. In the great majority of perinuclear cataracts radical operation by removal of the lens is indicated.

This operation can be performed in one of two ways: either by discission followed by a short incision of the cornea, or by immediate removal through a large curved incision. The latter method is adapted only for old persons in whom a hard nucleus has already formed. These cataract patients retain fairly good vision long after they have passed middle age; gradually, however, the opacity of the lamellar cataract or that of the nucleus increases and the patient is unable to work. The cortical layer, unless it has become cloudy from senile cataract, adheres to the capsule and has to be absorbed later. In childhood, on the other hand, which is the time when most lamellar cataracts are removed, the proper treatment is discission, because it at once induces opacity and softening of the cortical layer and of the nucleus and thus permits absorption to take place. In most cases, however, the swelling of the cortical masses forces the nucleus, after it has become more or less cloudy as the result of the discission, through the opening in the anterior capsule either as a whole or in fragments, so that the latter occupy the anterior chamber, and it is then advisable to make an incision in the cornea and evacuate the cataractous mass in order to shorten convalescence. In very small children and in larger children who are unmanageable it is of course wiser to avoid a corneal incision as much as possible and, whenever it is feasible, to be content with mere

incision and absorption. If, however, it becomes necessary to relieve the tension in the anterior chamber by evacuating its contents, it is best to make a short incision not more than 5 to 6 mm. in length between the edge and the center of the cornea.

The individual steps of this procedure have already been described, and it is evident that they must be carried out with due observance of antiseptic precautions.

Whenever in the case of older children it becomes necessary to remove the lamellar cataract without loss of time, as for example, in order not to keep the child out of school too long, it is advisable to divide the anterior capsule along with the anterior cortical layer by a liberal incision, which should even be carried into the nucleus so as to admit the aqueous humor. This is a better procedure in such cases than discission, performed with one needle in the manner already described, and is done with two Bowman's discission needles (Fig. 56). The two needles are inserted opposite the peripheral portion of the cornea, as shown in Plate 4, for the secondary operation on cataract; the points of the needles are then brought close together and introduced into the lens and then separated again, at first in a horizontal, and then in a vertical direction, so as to make quite a large and deep crucial incision. The object of using two needles is to avoid dragging the lens about and thus tearing the zonule. For the sake of greater security, if the child has not been chloroformed, which is as a rule an unnecessary precaution, it is advisable to have an assistant to steady the eye with a fixation-forceps in order to guard against any laceration through sudden movements of the globe. This is not shown in Plate 4.

In performing discission with Bowman's needles it is very important to see that the needles are properly constructed. Nowadays needles are manufactured which do not possess the chief advantage of Bowman's needles—namely, that of preventing the escape of aqueous humor during the operation. This is accomplished by making the needle thick enough so that the part immediately behind the point completely occludes the wound as the needle is thrust through the cornea.

Even if the latter is not introduced as far as the stop (Fig. 6 (*a*) 2), the wound is supposed to be closed not by the stop, but by the shaft between it and the point, which must be thicker than the point at its greatest width. As soon as the point has penetrated the cornea, the shaft (between 1 and 2) should at once completely occlude the wound. For in the case of children it may happen that the needle can not be inserted as far as the stop in this operation, and the stop can not therefore be used as an obturator. If the wound is properly occluded by the needle, the normal depth of the anterior chamber is preserved and the distance between the lens and the cornea does not change during the operation. But if the needle is not properly constructed, as shown in Fig. 6 (*b*), the large wound made by such a lance-shaped instrument will not be occluded by the posterior portion of the needle, the aqueous humor escapes along the shaft as soon as the edge of the needle has passed the cornea, and the lens at once approaches the cornea. Under such circumstances it is quite impossible to introduce the needle as far as the stop, so as to use it to occlude the wound, because by doing so the needle would be thrust too far into the lens. The aqueous humor accordingly continues to escape and, if discission is performed under such circumstances, there is great danger of tearing the posterior capsule also, because the lens rapidly advances toward the cornea, especially if the child begins to cry. An injury to the posterior capsule is a very serious blunder in this operation and brings its own punishment when the operator is later obliged to puncture the anterior chamber; for some of the vitreous is sure to force its way into the wound, which can not be regarded as anything but a very grave complication.

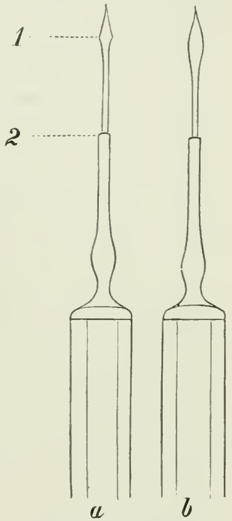

FIG. 6.—*a*, Discission needle properly constructed to occlude the wound; *b*, one that does not occlude the wound (greatly magnified).

When instead of Bowman's needles a capsular knife is used for this operation, as for example, Knapp's knife (Fig. 58), the knife must be constantly tested on the chamois to determine whether the shaft occludes the incision.

As soon as the capsule and the lens substance have thus been freely laid open, the lenticular material begins to become cloudy and rapidly swells. But by keeping the pupil dilated so as to prevent the formation of synechiæ

it is quite safe to wait until either the tension increases or a considerable quantity of gray cataract material has entered the anterior chamber, including within it the more or less fragmented and opaque nuclear portion. The more the anterior chamber becomes filled with this grayish, translucent mass, which resembles glue, the more easy will be evacuation with a keratome incision as sketched in Fig. 4. If necessary the puncture may be repeated if the first does not suffice to clean up the pupillary region.

If the tension becomes increased during the course of the treatment, the condition may be corrected by making a small puncture of the cornea with a narrow keratome or linear knife and, if necessary, repeating the operation. A rise in tension should never be regarded as an immediate indication for iridectomy. In fact, iridectomy, as has already been intimated, is to be excluded on general princlples in the case of young patients. If the iris glides into the wound after incision of the anterior chamber, it must be at once replaced with a spatula and contraction of the pupil brought about by instilling physostigmin. If an anterior synechia forms in the corneal opening it can be divided later in the manner to be described.

Finally, it is necessary in most cases, in order to obtain as good vision as possible, to perform discission on the posterior capsule and any remaining cataractous material; this is done in the same way as a secondary operation for cataract, which will be described.

The entire duration of the treatment when discission, combined with corneal incision, is used may be from six to eight weeks. If discission is used alone, without puncture, the treatment may last even longer; but the most important consideration in these cases is to choose the safest and not the shortest method, especially as most of the children have plenty of time and the danger of prolapse of the vitreous into the wound must be specially guarded against, because in children it is usually followed by bad recovery with iritis, cyclitis, and distortion and

occlusion of the pupil. The different operations must not be performed in too rapid succession, else there will be danger of iridocyclitis. It is also advisable not to operate on both eyes at the same time, because, if the child should be unfortunate enough to contract a disease—such as scarlet fever or diphtheria—accidentally, or the wound should become infected, both eyes might be destroyed.

It is most important in these cases of lamellar cataract to secure smooth recovery, with a round, perfectly movable, clean pupil in correct position for the reason, even when recovery is ideal, the visual power quite frequently turns out to be only moderately good (from $\frac{1}{3}$ to $\frac{2}{3}$), although there does not seem to be any cause for this want of success. Ultimate vision of $\frac{1}{3}$ constitutes a disability. If before the operation the patient had a visual acuity of $\frac{1}{4}$, and it is not increased by the operation, the removal of the lens has been of no benefit to him; for he has been deprived of his accommodation and will require a thick convex glass (cataract glass) for distinct near vision, and most patients who have to be operated on for cataract find this very unpleasant.

If, therefore, in a case of lamellar cataract the individual still has a visual acuity of $\frac{1}{4}$ to $\frac{1}{3}$, an operation is permissible only if there is some certainty that it will be followed by an uninterrupted recovery and a fairly good result; otherwise it would be better not to operate, for there is always a possibility of more favorable conditions for its removal developing later.

As a rule the opacity of a lamellar cataract and the reduction of vision are nearly the same on the two sides, but in some cases there is a difference. In such cases it is well to operate on the worst eye, and not to interfere with the other if near vision is still fairly good, so that, if the patient happens to loose his reading glasses, he is not entirely helpless so far as near vision is concerned.

The same treatment as for lamellar cataract is indicated for other stationary, partial cataracts in young individuals, such as spindle cataract, anterior and posterior polar cata-

ract, etc. These forms rarely come to operation. With regard to anterior polar cataract, which occasionally produces a distinct increase of the white discoloration at the anterior pole in the form of a pyramidal cataract, it is evident from what has been said about capsular cataract that it can not be removed by itself, as by scraping, for example, because it is a capsular cataract and is therefore underneath the capsule. Small opacities of this kind do not interfere with vision enough to require operation; large anterior capsular cataracts, which obstruct the greater portion of the pupillary region, must be treated either by doing a small optical iridectomy or by discission—*i. e.*, they must be removed along with the entire lens.

Opacities on the posterior pole of the lens, on the other hand, cause a much greater disturbance of vision. They are occasionally met in youthful individuals who present no other disease of the eyes. Strictly speaking, this form of opacity usually belongs to the progressive varieties, but it sometimes increases so slowly that it is impossible to wait for total clouding of the lens to take place. It is better to follow the same line as in lamellar cataract, providing there are no complications, such as iritis, vitreous opacities, choroiditis, or retinitis, to contra-indicate such a procedure.

(e) Operation for Senile Cataract.

The following points in the interesting history of operation for senile cataract are worthy of notice:

Until the year 1745, when Jaques Daviel (1696–1762) first removed a cataract from the eye, an operation for cataract consisted not in removing the cloudy lens from the eye, but merely in getting it out of the way, either by means of the so-called cataract puncture, by which it was pushed down into the vitreous (depression) or turned over backward (*reclination, couching*). This comparatively simple operation was usually performed by itinerant "cataract-stickers." If the operation was successful the patient, who before had been blind, at once was able to see with the aid of a cataract lens. Unfortunately, however, there were many cases in which the patient did not long enjoy this happiness. It often happened that the lens, after a short time, was again displaced by the vitreous body assuming its original position and again obstructing the view, and still more frequently it happened that the operation was

followed by infection or glaucoma with more or less pain and, ultimately, blindness. Glaucoma was frequently responsible for the destruction of eyes that had been treated in this way. Nevertheless this rude method of puncturing cataracts was carried on in many parts of Europe until well into the nineteenth century, and is still practised by the natives of India, where cataract is so common. For cataract extraction is a much more difficult and circumstantial operation and took some time to make its way in practice.

Daviel extracted the cataract through a corneal incision which took in from one-half to two-thirds of the lower circumference of the cornea, thus forming a large flap as wide as one-half the diameter of the cornea. Wenzel—both father and son—on the other hand, used a flap directed inward and upward. Gottlob August Richter, in Göttingen (1742–1812), and Beer, in Vienna (1763–1821), again made their incision at the lower border of the cornea with a somewhat smaller flap, although Richter raised the question whether it would not be better to make the incision above. The lower incision was, however, unquestionably easier of execution, because during the operation the eye is reflexly rotated upward as soon as the pain begins. For this reason

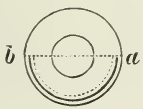

FIG. 7.—Flap incision (after Beer): *a*, *b*, Horizontal diameter of the cornea. The dotted curved line indicates the inner wound; the solid line, the outer wound.

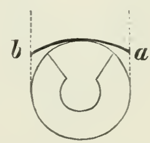

FIG. 8.—von Gräfe's linear incision.

most operators made the flap incision below until A. von Gräfe's time (see Fig. 7).

For the sake of greater security and to obtain a smooth incision special knives were devised. That of Beer had the form of a flat triangle (see Fig. 119).

After the incision had been made, the rest of the operation consisted merely in opening the capsule of the lens and delivering the cataract, with gentle pressure, through the capsular opening, the pupil, and the corneal wound. As it was customary, in order to obtain a better view of the cataract and assist in its escape, to dilate the pupil with belladonna, prolapse of the iris into the large corneal wound—an accident that is very apt to happen with this incision—was still further facilitated and frequently developed even after the operation. This increased the danger of wound infection, caused a faulty position of the pupil, disturbed the curvature of the cornea and, finally, left the eye with a tendency to glaucoma. It also happened quite frequently that the large corneal flap, either during or after the operation, would be turned over

Fig. 9.—Noyes' stop-speculum.
Fig. 10.—Clark's (Weiss) stop-speculum.
Fig. 11.—Weiss' stop-speculum.
Fig. 12.—Koster's stop-speculum.
Fig. 13.—Mellinger's stop-speculum.

The stop-specula shown in this and the following figure-plates (Figs. 14, 24, 33, 34) are intended to illustrate the most important models among the numerous instruments of this kind, both as regards the stop-mechanism, which in most of them consists of a screw, and in others of a ratchet (Figs. 12, 13, 34), and as regards the curvature and the construction of the arms of the instruments, which are introduced underneath the lids. In a number of the specula the latter are provided with a wire (Figs. 9 and 12) or a solid plate (Figs. 11, 14, 33) for protection against the lashes. A solid plate, however, takes up too much room unless it is curved, as in Lang's newest model (Fig. 33). One of the first requisites of a good speculum is that it shall be possible to close it quickly and surely, so that it can be removed from the eye without difficulty.

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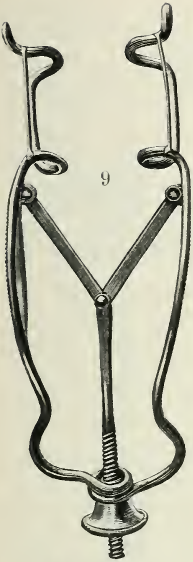
backward by spasmodic closure of the lids, and the bruising to which it was thus subjected also gave rise to infection and suppuration. In fact, suppuration was not at all rare after the operation, occurring in 5 to 10 per cent. and more of the cases. It was a complication that was specially dreaded, and thoughtful operators attributed it chiefly to the large size of the flap and to the fact of its occupying a tissue poorly supplied with blood-vessels and therefore unfavorably situated for nutrition, as it was not difficult to show that similar but smaller incisions, as, for example, in iridectomy, showed much less tendency to suppuration.

The result of this reasoning was that Jacobson gave up the large corneal incision and instead incised the lower border of the sclera; this, however, increased the danger of escape of the vitreous to such a degree that the operation was found to be impossible except under profound anesthesia.

Albrecht von Gräfe (1828–1870), of Berlin, who brought about a complete revolution in the method of treating a cataract, not only transferred the incision to the sclera, but reduced its size as much as possible, which, of course, made the escape of the cataract more difficult. He also tried to avoid the formation of a flap altogether by placing his incision as much as possible in the meridian of the globe, so that, when viewing the meridian from above, the incision formed a straight line. Hence, von Gräfe's incision was called the "linear incision," and his method the "linear extraction" and, in contradistinction to the already mentioned simple operation, the "modified linear extraction." As the incision was so very near the periphery, and, owing to the small size of the wound, the iris got in the way of the escaping cataract and suffered more or less contusion, depending on the size of the hard nucleus, von Gräfe added iridectomy to the cataract incision; and in order to minimize the disadvantage of allowing so much light to enter the eye, as well as to avoid disfigurement, he placed



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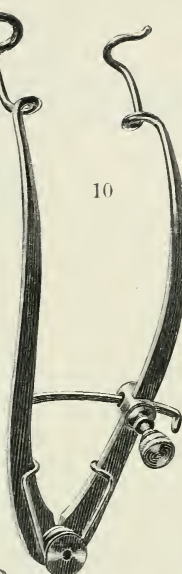

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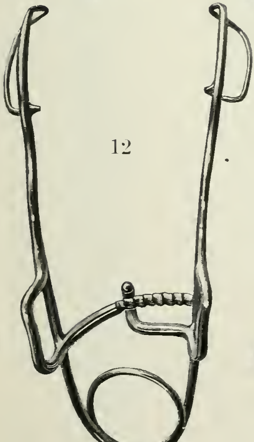

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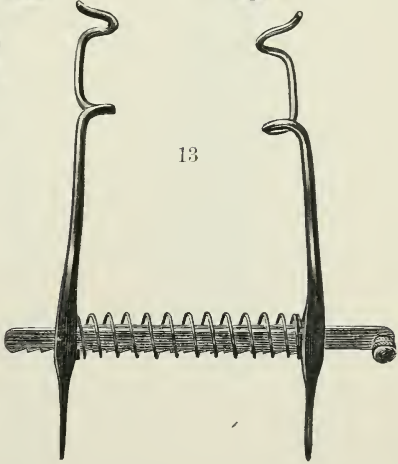

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FIG. 14.—Gaupillat stop-speculum with jointed blades and movable end-plates.

FIGS. 15, 16.—Desmarres' speculum.

FIG. 17.—Simple wire-speculum, showing at the other end Jager's horn spatula for operations on the lid.

FIG. 18.—Noyes' speculum.

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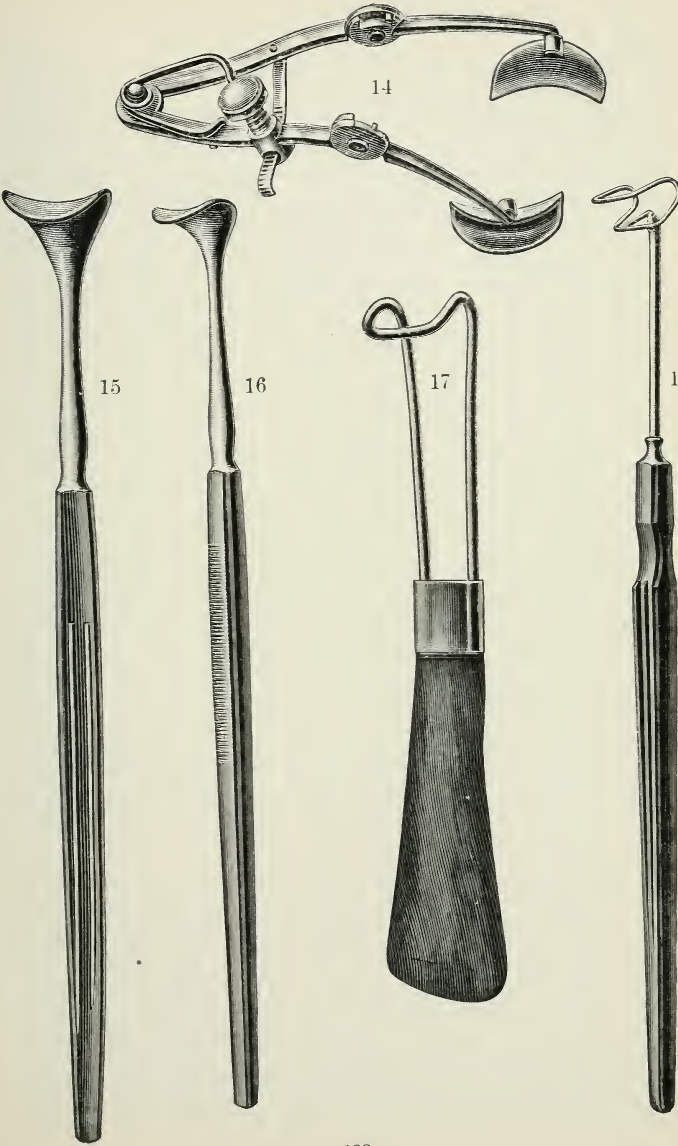
the incision for extraction above, so that the iridectomy (coloboma) was covered by the upper lid. To insure greater accuracy in making the incision he devised a special, narrow knife, resembling a spear of grass (see Fig. 26).

A narrow blade of this kind was, it is true, the best instrument for making this somewhat difficult linear incision, which was bounded at the extremities by the two lateral tangents of the cornea (Fig. 8); but even with Gräfe's knife it was a difficult feat, after entering at *a* and advancing the point toward the middle of the pupil, to make the wound of exit correctly at *b*. In his desire to make the wound large enough the operator was apt to bring the point of the knife out at a point too far away from the corneal margin, thus getting into the dangerous region of the ciliary body; or, in his anxiety to avoid the ciliary body, he would bring out the knife at a point too near the corneal margin, and thus make too small an incision, through which it was difficult to deliver the cataract, even after the iris had been excised and the capsule opened with the knife (Fig. 29) introduced by von Gräfe. Thus the escape of the lens had to be assisted with spoons, and a good deal of the cortical matter was thus scraped off and remained in the eye, to be either curetted out or "milked out" with the lower lid—that is, the operator, after removing the speculum and fixation-forceps, kept up a kind of massage of the lid for some time, exerting more or less pressure on the lid with the finger, and pushing it from below upward over the cornea in order to express the remains of the cataract through the wound, which would gape of its own accord. Personally I have no doubt whatever that this milking movement, by expressing the contents of the glands in the lower border of the lid, was often a source of infection; for we know that the edges of the lids are very frequently the most infected part of the eye. Sometimes, when this method of milking was resorted to, the operation would terminate most disastrously in prolapse of the vitreous, for the peripheral wound was uncomfortably near the vitreous.

As the incision was also very near the ciliary body, inflammation of the wound was very apt to be followed by dangerous cyclitis, causing not only blindness in the operated eye, but not infrequently destroying the other eye as well, through sympathetic inflammation.

However, postoperative suppuration diminished, and the fact that iridectomy had to be accepted in this method was less objectionable, because the defect was covered by the upper lid. Owing to the diminished curvature of the incision, the wound healing more rapidly, and the shortened length of the incision were probably chiefly responsible for the better results that were obtained; for, as we now know, it was a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mistake to suppose that iridectomy diminishes the danger of postoperative inflammation.

Nevertheless the danger of this incision caused even a partial return to the corneal margin, even among many of von Gräfe's followers, thus giving the incision a certain degree of curvature. Iridectomy, however, was retained. During the seventh and eighth decades of the last century, when the knowledge of antisepsis and asepsis and of the use of miotics and of cocain was gained, there was a growing tendency to return more and more to the old flap incision and to suppress iridectomy whenever possible. As the true causes and correct method of combating suppuration became better known the dread of such a complication diminished correspondingly. Prolapse of the iris, it was found, could be combated by means of the miotics, especially physostigmin, and it became possible to retain the upper incision because the pain of the operation was practically reduced to zero by the use of cocain.

Incidentally it was also found that it is easier to get along without iridectomy if the incision is so large that it takes in nearly, if not quite, one-half of the cornea, and it was also found that the incision may safely be quite near the periphery, although it might be supposed *a priori* that these two factors would favor prolapse of the iris. The reason is that when the incision is large and near the periphery the cataract can escape much more easily without any contusion of the iris. It is true that the iris is momentarily subjected to great distention as the cataract escapes through the pupil; but if it has not been previously paralyzed by atropin it usually contracts again vigorously and returns into the anterior chamber to its proper position, which it will retain if the patient afterward remains quiet until the wound has united. Reopening of the wound, however, may at any time be followed by prolapse of the iris, because the aqueous humor washes the iris into the wound. It is therefore wise to assist rapid closure of the wound by making a conjunctival flap.

Preparatory Treatment for Operation on Senile Cataract.—All preliminary procedures, including examinations, must be carefully carried out with due regard both to the patient's general health and the condition of the eye, as well as its functions.

With regard to the *functional examination*, especially that of the macula lutea, the following should be borne in mind: In the case of a cataract that has not become completely opaque, although operable, central vision (according to Pagenstecher) may be tested by dilating the pupil and examining the patient with the stenopeic slit-hole and a strong convex lens, moving it back and forth in front of the dilated pupil until the patient finds the clearest spot in the lens. The size of the finest print that the patient is able to read will serve to indicate the visual power of the macula. This method of examination is useful when it is possible to see changes in the macula through the opaque lens, and there is a doubt in the examiner's mind whether the condition of the macula is still good enough to justify operation on the cataract.

If the patient is intelligent, Pagenstecher believes that the behavior of Purkinje's vascular figure will indicate the functional condition of the macula, even when the lens is completely opaque.

As regards the general condition, it is, above all, important to examine the urine once or twice for albumin, taking a specimen of the urine passed between 10 and 12 o'clock in the morning, as well as for sugar, taking for the latter purpose a specimen of urine passed between 3 and 4 o'clock in the afternoon, after a meal containing carbohydrate and sugar.

Fever, even of a very slight degree, is a contra-indication.

It is especially important to examine a patient with a cataract for the presence of suppuration in any part of the body (leg-ulcer, eczema, fistula of any kind), and for any spot on the skin that may become the starting-point of erysipelas (fissures behind the ears and at the nose, etc.). All such sources of wound-infection must be rendered innocuous, either by curing them or covering them with an antiseptic dressing before the operation is undertaken.

The most dangerous form of suppuration for a cataract patient is suppuration in the lacrimal sac. Even a mere purulent catarrh in its structures suffices to cause a most destructive infection of the cataract wound. Mere external inspection of the eye and pressure on the lacrimal sac are not sufficiently accurate methods of determining whether the lacrimal passages are normal; it is much better in every case to inject fluid into the lacrimonasal duct, as explained on p. 56, and to carry out the other procedures advised at that place. This injection of the lacrimonasal duct (the technic of which will be more accurately described in the section devoted to Operations on the Lacrimal Apparatus) may be performed the evening preceding the operation or in the morning, immediately before beginning the operation.

The conjunctiva also must be carefully examined, as conjunctival catarrh may be quite as dangerous as catarrh of the lacrimal sac. Conjunctival catarrh, to which old

persons are so predisposed, must first be removed. If the conjunctiva merely appears somewhat suspicious it should be treated prophylactically, at intervals of twenty-four hours, with a 1 per cent. solution of silver nitrate, especially if the dressing (presently to be mentioned) shows the presence of some secretion. [A 25 per cent. solution of argyrol, or 20 per cent. solution of protargol is even more valuable.—Ed.]

Blepharitis is also a contra-indication; when it is only moderate, however, the operation may be performed, provided an ichthyol dressing is used.

The operator must never forget to test the intra-ocular tension several times in every case of cataract. If the tension is found to be heightened from time to time, even if the increase is only small, iridectomy should be performed first, and the treatment with miotics kept up until the tension has become normal, for glaucoma following an operation for cataract is a grave condition that is often difficult to correct.

Examination must also include the other eye in every case. If it shows signs of disease, especially of iridocyclitis or glaucoma, such conditions must first be removed. If it is phthisical and sensitive to pressure it is better to perform enucleation first, especially if the phthisis has followed an injury or operation. An eye which, owing to cyclitis, is in danger of producing sympathetic disease of the eye needing operation, or has already produced such sympathetic disease, or only sympathetic irritation, ought to be enucleated before the other eye is operated upon, if it is blind or has defective projection; and enucleation should take place about six to eight weeks before the cataract extraction. This is because the cataract operation may convert a mere sympathetic irritation into sympathetic inflammation.

In addition there are certain other preliminaries to be observed before an operation for cataract:

1. A bath for cleansing purposes, or even several, if necessary, in the case of dirty patients.

2. The eyelashes should be carefully cut off without injuring the skin of the eyelid, and the eyebrows must be either trimmed or shaved; the latter especially in the case of dirty persons. This should be done an hour—or immediately—before operating.

3. On the evening preceding the day of operation the eye to be treated should be bandaged, and the bandage must remain in place until the operating period, being moistened from time to time with a 1 : 5000 solution of bichlorid of mercury. This preparatory bandage has the following advantages: The patient's sensitiveness to bichlorid of mercury is determined; for it is well known that there are individuals in whom even a small quantity of very weak bichlorid-of-mercury solution produces a dermatitis, which often discharges for days in a most unpleasant manner, even if the use of the remedy is at once discontinued. A dermatitis of this kind, surrounding an eye from which a cataract has been extracted, is capable of seriously endangering recovery. If on the morning after the moist bichlorid bandage has been applied the skin appears in the least reddened, operation must be delayed until the skin has become normal; and in such a case the use of bichlorid of mercury must be avoided, both before and after the operation, simple sterilized water being substituted in its stead.

The trial bandage also shows whether there is any conjunctival secretion, which, if present, will be found on the cotton pad that covers the eye. In such a case the operation is also postponed until the catarrh has been cured; or at least, if the conjunctiva shows but little catarrhal change, it is painted once or twice with a 1 per cent. solution of silver nitrate as a matter of precaution. [Argyrol or protargol may be used.—Ed.]

The chief advantage of the preliminary bandage is that it makes it easier to secure thorough cleanliness of the skin of the lids and surrounding parts before the operation, because these parts are softened by the moisture of the bandage.

Fig. 19.—Pamard's instrument for fixing the eyeball.

Fig. 20.—Dujardin's forceps for the same purpose, provided with a lock.

Fig. 21.—Fixation-forceps without a lock.

Fig. 22.—Noyes' curved fixation-forceps with a lock.

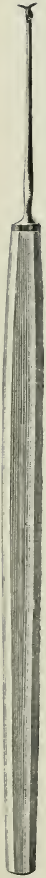
Fig. 23.—Fine-toothed forceps.

Fixation-forceps should be broad in front and provided with teeth, which should not be too sharp, so as not to tear through the conjunctiva, and thus defeat their purpose. If the conjunctiva is friable, the instruments illustrated in Fig. 19 or 20 may be used.

[The editor doubts the necessity and even the wisdom of a preparatory bandage as described. It is apt to disturb the rest so much needed during the night prior to the day of operation, and tends to encourage hyperemia of the conjunctiva. If it is used the pad should be soaked in boric-acid solution or sterile water, because many patients will not tolerate a sublimate solution.—Ed.]

4. The bandage having been removed immediately before the operation, cocain is instilled into both eyes to guard against the disturbing accident of reflex closure of the lid, in case a drop of fluid of any kind accidentally gets into the other eye during the operation. All that is necessary, as a rule, is to instil 5 drops of a freshly boiled 3 per cent. solution of cocain at intervals of three minutes, [or 3 drops of a 4 per cent. solution of cocain at intervals of five minutes. Some operators prefer a 1 per cent. solution of holocain.—Ed.] In the case of patients with little self-control, and in cases in which, owing to marked myopia, for example, prolapse of the vitreous is to be feared, it is well to instil a drop of a 3 to 5 per cent. solution of cocain every three minutes for one-half hour. To prevent the cornea from getting dull and opaque, the eye is covered with wet cotton while the cocain is being instilled. [The editor prefers not to make such frequent instillations of cocain; in spite of all precautions they tend to cause opacity of the corneal epithelium, and encourage subsequent collapse of the cornea.—Ed.]

5. All the attendants whose fingers come in contact with



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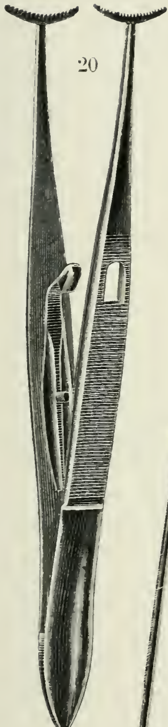

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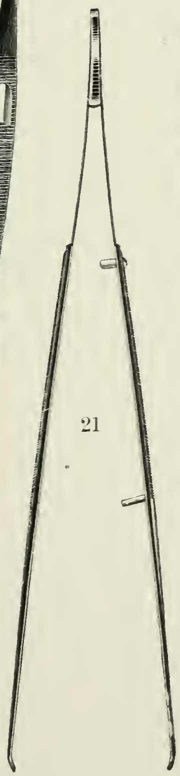

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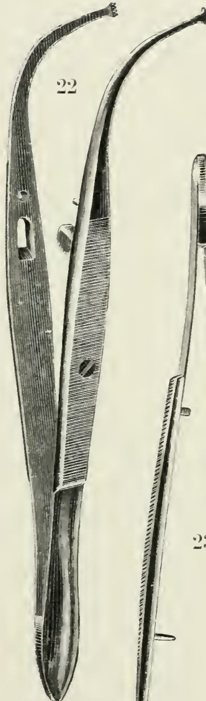

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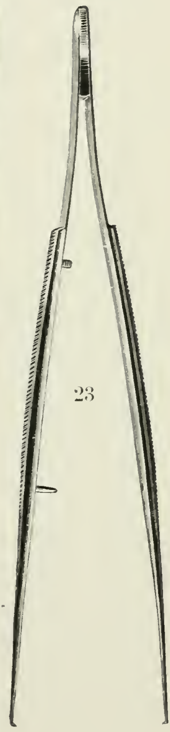

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the operative field should disinfect their hands with soap, hot water, a sterilized brush, 60 per cent. alcohol, and, finally, bichlorid of mercury and trichlorid of iodin in the strength of 1 : 1000. As, however, it is not always possible to be quite certain that the hands are sterile, it is always best to adopt the rule not to touch the operative field with the fingers, but only with sterile instruments, and not only during and after the operation but also before the operation, while cleansing the parts in the manner now to be described.

6. The next step is the cleansing of the operative field:

(*a*) All the external skin covering the forehead, cheek, and nose, as far as the edges of the lids, to be washed first with the tincture of soap and hot water, then with alcohol, and finally with a 1 : 1000 solution of bichlorid of mercury, the cleansing with all these materials being done with cotton pledgets. The preliminary softening of the skin by the wet bandage materially facilitates this laving process.

The cleansing of the edges of the lids, which must be performed cautiously but thoroughly, is of the utmost importance.

(*b*) Next the conjunctival sac is thoroughly flushed out by pouring a 1 : 5000 solution of bichlorid of mercury or carefully sterilized saline solution from a suitable vessel on the everted lids and transition folds, rubbing the parts at the same time with small pledgets of sterilized gauze; or glass rods tipped with cotton may be kept ready for use as sterile sponges, and these may also be used for cleansing the conjunctiva by thoroughly wiping all the folds of the membrane. After the lids have been replaced, the bulbar conjunctiva, the inner canthus, and especially the region where the cataract incision is to be made, should also be gently wiped off and irrigated. The edges of the lids must be once more carefully wiped off, because the manipulation during eversion may have expressed some of the contents of the Meibomian and other glands in the edge of the lid.

If there is a dacryostenosis without so much secretion as would necessitate extirpation, the upper and lower lacrimal canaliculi must be closed with the galvanocautery, as described on page 58, after which the inner canthus is once more flushed out. It is important to begin the operation immediately after the cleansing has been completed, because the cocain anesthesia soon disappears. As the cleansing of the conjunctival sac produces some reddening of the mucous membrane, the anesthesia rapidly disappears and can not be maintained by the further addition of cocain unless adrenalin is instilled at the same time. The patient's head, especially the hairy scalp, having been covered with sterilized gauze so as to leave only the eye and its immediate neighborhood exposed, and the operator, having satisfied himself that the light falls on the operative field from the right direction, and that the electric light is ready for any emergency—the latter being the exclusive source of illumination on dull days—each attendant takes up his proper position and begins his duties, and all is then in readiness. As regards the position of the operator and his assistants, it is obvious that the operator, who always stands at the patient's head and operates on the right eye with the right hand and on the left eye with the left hand, must have the most comfortable position. If he is not ambidexter he will have to stand to the left of the patient when operating on the left eye.

One practised assistant is indispensable, and a second is much to be desired. The former, who stands facing the operator, manages the lids and, if an iridectomy is to be performed, steadies the bulb.

The larger the corneal incision and the more it resembles a flap incision, the more important it is to hold the lids well apart. If a stop-speculum, like those illustrated in Figs. 9–13, is used, the assistant must hold it tightly by its peripheral extremity so long as it remains in the eye, and keep it away from the globe so that, if the patient winks, the lids will be unable to exert injurious

FIGS. 24-31.—Instruments required for an operation on senile cataract. Other instruments of the same kind may, of course, also be used.

FIG. 24.—von Gräfe speculum.

FIG. 25.—von Gräfe fixation-forceps with lock.

FIG. 26.—von Gräfe cataract-knife.

FIG. 27.—Iridectomy forceps.

FIG. 28.—Iris scissors, curved.

FIG. 29.—von Gräfe cystotome. The other end of the instrument is provided with a metal scoop, to assist in the escape of the cataract.

FIG. 30.—German-silver spatula for replacing the iris, etc.

FIG. 31.—Weber wire-loop.

Even when the operator intends to extract without performing an iridectomy, the iridectomy instruments—forceps and scissors—must be kept in readiness. The combination of cystotome and scoop is not to be advised, because in using the cystotome the operator is apt to touch something with the scoop end. It is better to use the cystotome (Fig. 40) and the scoop (Fig. 35) separately.

The wire-loop should be laid out ready for use at every operation.

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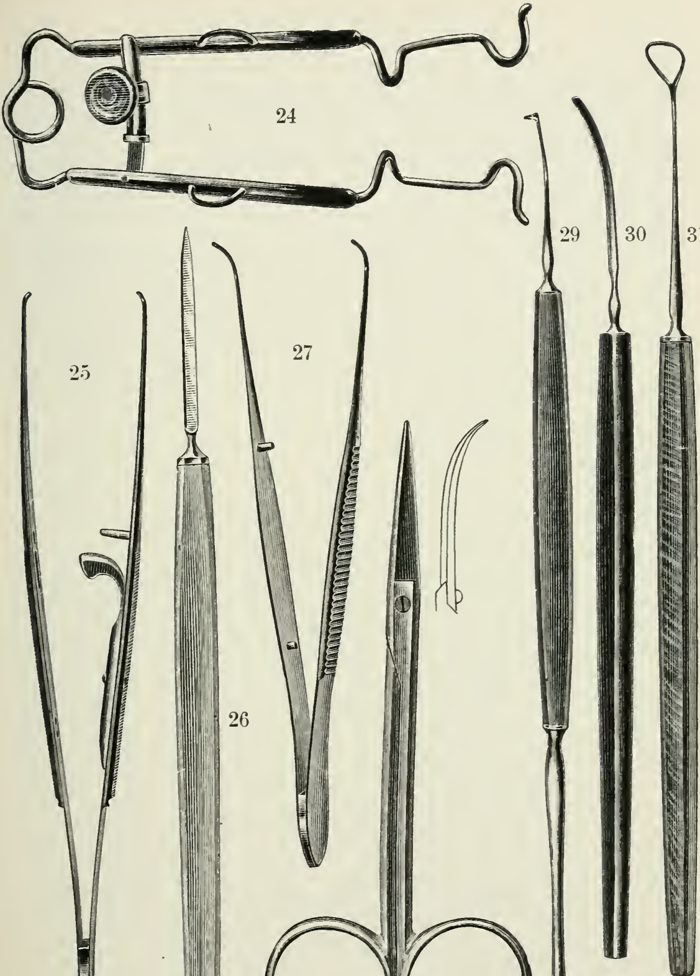
pressure on the eye. Many operators prefer to have the lids held apart with single specula or retractors, as, for example, Pellier's instrument (Fig. 32), especially when they operate without iridectomy. Others merely have the assistant draw the lids apart. In that case the assistant should cover the fingers that he uses for that purpose with sterile gauze, to enable him to get a firm grip of the lids. Unless his fingers are very slim, however, they are apt to be in the way, and, as a rule, a properly handled lid-speculum is to be preferred.

If the assistant is to hold the speculum in the way that I have described he must pay attention to the following points: He must not go too far in his effort to hold the speculum away from the eye, to protect the organ from injurious pressure by the eyelids when the patient shuts his eyes tightly, for fear of the instrument suddenly and entirely slipping out from under the lids, especially when the lids are rather long and flaccid, as such an accident would be followed by unpleasant consequences. Again, during the delivery of the cataract, when slight pressure on the globe may under certain circumstances be desirable, he must relax his hold on the speculum, but not relinquish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it. In order to be able to do do all these things properly the assistant who is charged with this duty must have a firm footing—for the work he has to do is of a most particular kind. The second assistant, who stands by the side of the operator, hands him the instruments, taking great care to avoid contaminating any. If necessary, he also looks after the electric light; although it is better to have this duty attended to by some one else. Finally, some one must hold the patient's head, taking care, of course, to keep his or her hands under the gauze covering.

Instruments, sponges, dressing-material, etc., should be laid on a small operating table, close to the patient's head. During the entire operation water should be boiling in the immediate neighborhood, so that an instrument may be plunged into it at any time, if necessary; for, in spite of the utmost precaution, it may happen to come in contact with something outside of the sterile operative field and have to be at once sterilized again.

The patient lies on his back, either on the operating table or on his bed, with his head slightly raised and in as comfortable a position as possible. The operator, having provided himself with a mouth-mask, which I have now used for two years, gives him the necessary instructions, telling him specially not to hold his breath during the operation and not to bear down. The mouth-mask makes it possible to talk to the patient quietly; and if the latter, as is usually the case, is excited, this has a very quieting effect, providing the physician himself is cool. By judicious encouragement it is very often possible to quiet the patient's fears and remove all dread of the operation.

Nobody but the operator should talk or give the patient any instructions, as it would only confuse him.

[Professor Haab's directions are so explicit, in so far as the preparation of the region of operation and instruments are concerned, that additional comments may seem superfluous, but the editor feels that the method used by himself and many colleagues is worthy of record here.

Referring especially to the preparation of the eye itself

for some days previous to the operation, the editor believes, with Knapp, that it should be protected from anything which may produce congestion, and that the patient should remain in the hospital, perfectly resting his eyes and body, and frequently washing his face and the surface and margins of the eyelids with soap and water. If there should be any discharge from the conjunctiva and a tendency of secretion to gather at the commissural angles, an instillation of a 25 per cent. solution of argyrol, two or three times a day, is of great advantage. During these days scrupulous attention should be given to the nasopharynx. In recent years the editor, following a suggestion of J. A. Lippincott, has been accustomed to spray the nasopharynx three times daily with a solution of permanganate of potassium (1 : 5000) with gratifying results.

In the preparation of the skin of the region of operation the following plan is pursued: The skin is treated first with soap and water, then with alcohol, and finally with corrosive sublimate (1 : 2000). These irritating substances are not allowed to enter the conjunctival sac, but the face, surface of the closed lids, eyebrows, brow, and scalp above the brow are thus prepared: The ciliary margins are cleansed with soap and water, followed by bichlorid of mercury (1 : 5000). The parts are kept covered with a compress of lint soaked in a bichlorid solution (1 : 5000) or in boric-acid solution for at least an hour prior to the operation and after the preparation just described has been completed.

Just preceding the operation, the preparatory bandage is removed, the ciliary margins again cleansed with bichlorid of mercury (1 : 5000) with the same precautions previously described. Next the conjunctival cul-de-sac is flushed with a tepid solution of boric acid, applied with some force, or with a sterile physiologic salt solution. During these irrigations, pressure should be made over the lacrimal sac in order to be sure that no deleterious secretion is contained within it; or its condition may have

Plate 2.

Operation for Senile Cataract: The cataract-knife has been carried through the anterior chamber, and the incision is now being made upward.

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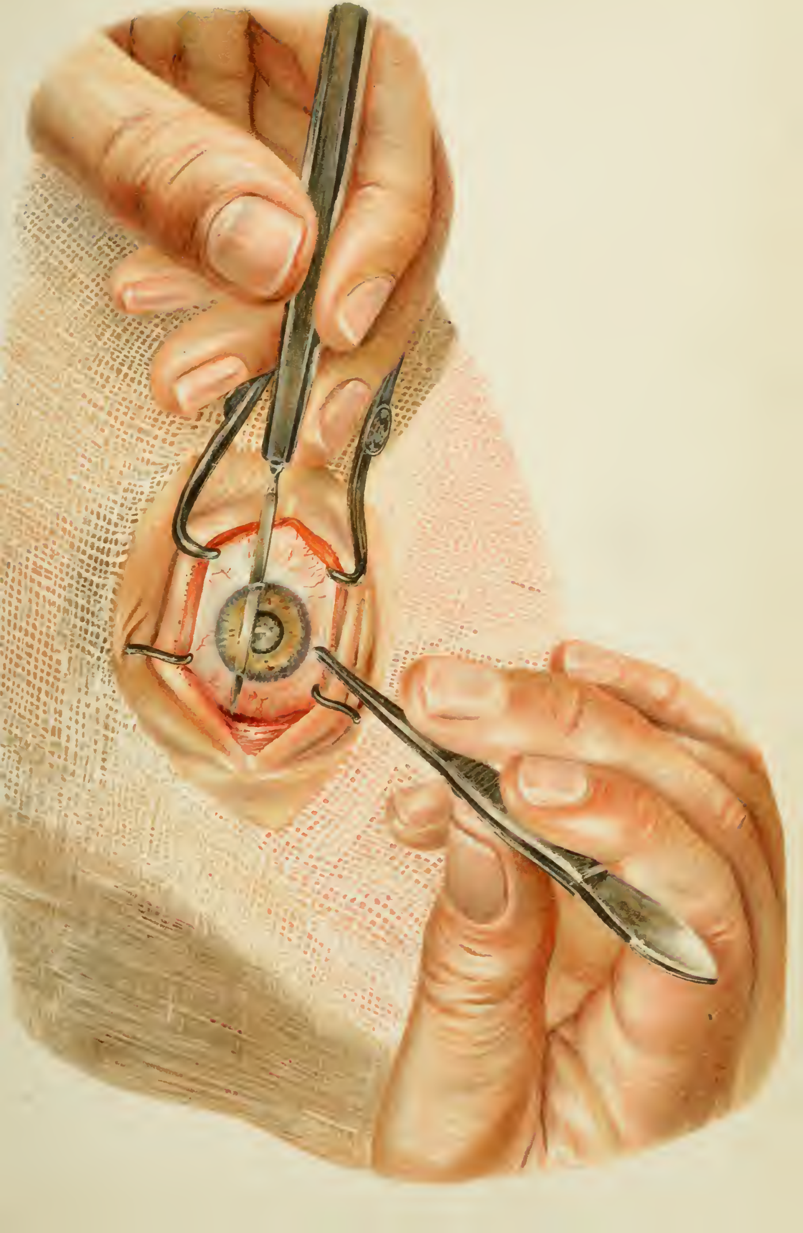
been ascertained previously by injecting it with an Anel syringe, in the manner described by Dr. Haab. The lids are then everted, the tarsal conjunctiva and the region of the inner canthus wiped with a pledget of cotton moistened in boric-acid solution. If there is any suspicious redness in the region of the caruncle at the conclusion of the operation and before the bandage is applied, this is dusted with sterile iodoform powder.—Ed.]

Cataract Extraction with Iridectomy.—For this procedure the instruments illustrated in Figs. 24–31 are required. The speculum having been introduced and locked, so as to make it impossible for the lids to close, the globe is seized with the fixation-forceps immediately below the cornea, utilizing a fold of the conjunctiva (see Plate 2), and the knife, held with the edge upward, is introduced into the upper part of the anterior chamber, making a corneal incision, the size of which is gauged by the size of the nucleus of the cataract and the size of the cornea. The darker and more yellow the nucleus appears through the small quantity of cortical matter, the larger it will be. If, on the other hand, the cortical material represents a thick layer surrounding the nucleus, as, for example, in young individuals, such a condition betrays itself by the fact that the grayish, translucent, rather milky coloration extends deep into the cataract. The diameter of the cornea also may be quite variable. The cornea may be small without the cataract behind it necessarily being small also, and in such cases it is specially important not to make the incision too small. The height of the flap must be increased, and the incision must, if possible, lie entirely within the scleral border. If the cornea is large, as is sometimes the case in myopic eyes, the flap need not be so high as shown in Plate 2, espe-



cially if marked myopia is actually present. In a myopic eye of this kind it is important to guard against the loss of any vitreous material, the danger of which is greater when the incision lies within the scleral border. It is therefore advisable in these cases to keep the incision entirely within the cornea. It appears, therefore, that in making the incision for cataract extraction it is necessary to individualize; but it is always better to make the incision somewhat too large than too small.

Having carefully noted the points where the instrument is to enter and to emerge, the knife (which is held like a coffee spoon) is rapidly carried through the anterior chamber, in doing which the operator must not bear heavily with his hand on the patient's head and, if possible, should not support his hand at all. The incision is then completed by drawing the knife backward and forward—that is, by a sawing movement, closely following the corneal border. Beginners, in making these incisions, often make the mistake of bearing too hard on the edge, and not drawing the knife backward and forward enough. The more the edge of the knife is drawn backward and forward against the object to be divided, the better the knife will cut. This is specially true of hard tough objects, of which the cornea is a very good example; for it does not belie its name. Only soft substances, like butter, or semisolid material of uniform consistence, like paraffin, can be divided or crushed apart by direct pressure on the edge—that is, by using the knife like a chisel. But in drawing the knife backward and forward there is danger in the case of deep-set eyes of injuring the inner canthus, or the upper margins of the lids, which are not rendered insensitive by the cocain. This causes the patient to jerk and wink, and in that way escape of the vitreous immediately after the incision has been made becomes possible. [The wound margins will be smoother if, after puncture and counter-puncture, the knife is pushed steadily onward as far as possible, with an upward tendency, and the incision is completed by a free cutting, not a sawing or dragging

movement, keeping the knife in the same plane throughout the procedure.—Ed.]

From this we deduce the important rule that, in making the incision, the operator must keep his eye not only on the edge of the knife, but also on the point. The other hand, which holds the fixation-forceps, must also be carefully controlled by the operator. If, as the beginner in operative work is apt to do, the surgeon directs his attention exclusively to the cutting hand, he is in danger of unconsciously exerting a most injurious pressure on the globe with the forceps, "by way of emphasis," and as a result the knife, as it completes the incision, may be followed by the sudden escape of vitreous. For this reason it is a good plan to support the hand which holds the fixation-forceps (even when that duty is entrusted to the assistant) on the patient's upper jaw as the globe is seized and held fast, so that once the proper position for fixation has been taken, any pressure on the point of the forceps becomes absolutely impossible, because the hand or the tips of the fingers rest against the patient's jaw.

Another reason for making the incision slowly is that the aqueous humor ought not to escape through the anterior chamber too rapidly, because a sudden lowering of the pressure favors the occurrence of intra-ocular hemorrhage. It must not be made too slowly, however, because in that case all of the aqueous humor escapes, carrying the iris with it and bringing it in front of the knife; although, if such an accident happens, the incision should be quickly completed, for the iridectomy will then be performed at the same time, although not in the regular way.

When it is necessary to make a conjunctival flap, the customary upward rotation of the edge of the knife, which is performed as the last fibers of the membrane are divided, so as to bring the knife out of the tissue before leaving the cornea, is omitted and the incision is continued a little farther in the direction of the sclera, under the conjunctiva, which is loosely attached to that membrane. The knife is thus carried some little distance under the

conjunctiva before it is rotated upward and brought out of the tissue. In order to prevent the conjunctival flap from becoming a disturbing factor in the iridectomy, it should be at once turned back over the cornea with the point of the knife, as otherwise it is apt to be cut off along with the iris.

The next step is the iridectomy. The fixation-forceps is handed over to the assistant, who gently rotates the globe downward, enabling the operator to introduce the curved iris-forceps and seize the membrane. The forceps is introduced closed and carried near the edge of the pupil; it is then opened a little, gently inserted into the iris, closed again, and drawn out of the wound, so that the iris can be cut off with a single snip of the scissors, the curved blades of the iridectomy-scissors being pressed firmly against the wound. It is not necessary to excise a large section of the iris in operating for cataract.

After the iridectomy the capsule of the lens is opened. The cystotome, with the blunt part foremost, having been introduced into the pupillary region, lacerations are made with the sharp point of the instrument from the lower edge of the pupil upward almost to the wound, as well as crosswise, so as to lacerate the capsule. The knife should not be introduced deep into the lenticular substance, so as to touch the nucleus and displace it. The instrument must be sharp, in order not to catch in the capsule and cause luxation of the entire cataract when traction is made on the instrument. It must not act like a blunt hook, pulling on the capsule and tearing the zonule of Zinn, thus producing a prolapse of the vitreous.

Whenever, therefore, as happens in the case of overripe or complicated cataracts, the anterior capsule is thickened at its center and shows the senile capsular cataract, which is recognized by a paler or even a white discoloration, it is better, in opening the capsule, to cut around the thickened capsule with the knife, completing its removal with the forceps before proceeding with the delivery of the cataract. The thickened capsule may

Plate 3.

Reposition of the iris with the spatula at the end of an operation for senile cataract. The gauze with which the parts around the eye are covered is not shown in the picture.

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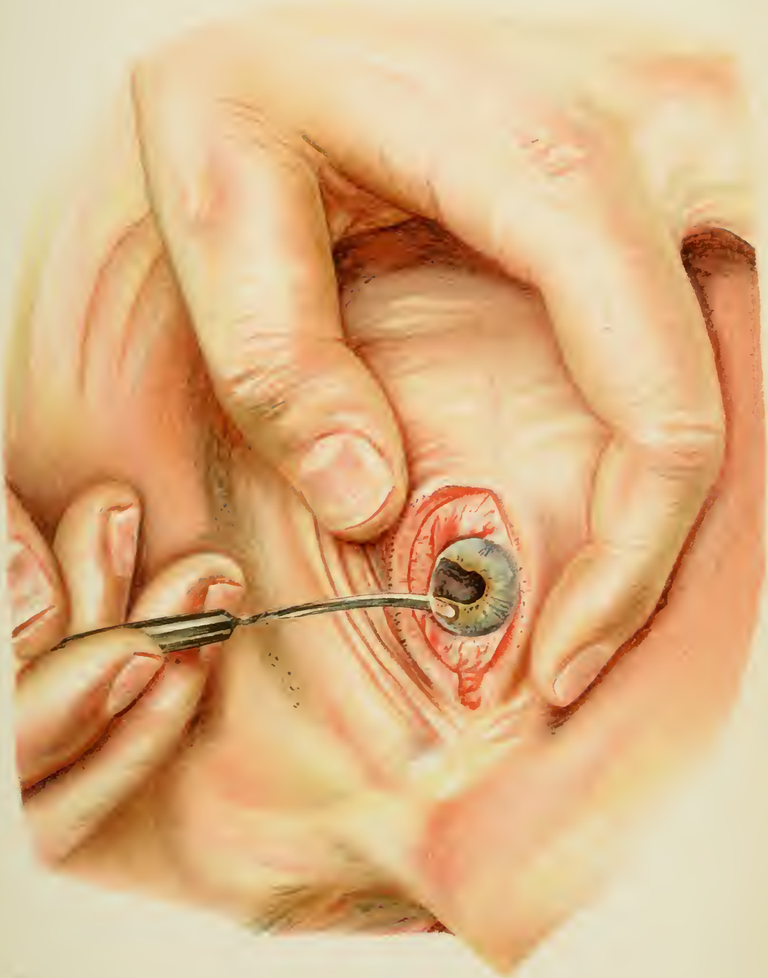
also be seized and lifted out with specially devised capsule-forceps (Figs. 44 and 46). In fact, some operators prefer to open the capsule with the capsule-forceps in every case, because a large piece of the anterior capsule is thus entirely removed, and the cause of secondary cataract is in part obviated. Unless the forceps is very well made, however, and is delicately and ably handled, the operator is very apt to tear the zonule of Zinn, either by pressing on the cataract as he seizes the capsule, or by dragging on the capsule as he tears it out, and thus cause prolapse of the vitreous.

After the capsule has been opened, the delivery of the cataract is a comparatively simple matter. The operator, who has resumed the fixation-forceps after completing the iridectomy, exerts moderate pressure on the globe with the instrument and thus forces the lower edge of the cataract somewhat backward. As a result the upper border is tilted slightly forward and enters the corneal wound. To complete the delivery of the cataract the operator resorts to a suitable, curved, spoon-like instrument (Fig. 29), preferably made of glass (Fig. 35), which he carries across the cornea from below upward, exerting more or less pressure, and thus stripping out the cataract. Usually part of the soft cortical matter escapes first, the nucleus then presents and slips out, followed by remains of the cataract consisting of cortical matter ; or fragments of the nucleus are stripped out in a similar manner until the pupillary region appears to be as clean as possible—that is, black.

This, however, does not end the operation. The iris, which is usually pushed into the wound during the delivery of the cataract, must be freed, and replaced as nearly as possible in its normal position. The iris must



never be allowed to stay in the wound during an operation, and this principle applies to operations on cataract also. With the spatula (Fig. 30), therefore, the iris, which lies in the angles of the wound, is carefully replaced by carrying the instrument cautiously from the angle of the wound toward the center and slightly inward toward the pupil (see Plate 3), so that the corners of the sphincter occupy their normal positions.

Allowing the iris to remain within the wound also has the following disadvantages: (1) The pupil is too high, which is undesirable, because only the central portion of the cornea possesses the curvature necessary to form a sharp retinal image. (2) Astigmatism increases after the operation, because the iris is caught in the scar and prevents the cornea from regaining its normal curvature, which is for a time impaired by the cataract incision. (3) The possibility of iritis following the operation is greater when the iris is caught in the scar. (4) The tendency to increased intra-ocular tension (glaucoma) is greater for all time in an eye of this kind. (5) If the adhesion of the iris is large, as is apt to be the case, and increases as healing progresses, it becomes a permanent disability, because a scar that contains a portion of the iris may become the port of entry for an infection, which in a short time may lead to panophthalmia, and therefore to loss of the eye, unless the infection can be removed with iodoform, as has been mentioned elsewhere in this work.

If some tissue remains behind after the escape of the cataract, especially in the region of the pupil, an attempt may be made to strip it out, not as was formerly done with the aid of the lower lid, because the edge of the lid is apt to cause infection of the wound, but with the same instrument that is used for the delivery—namely, a glass spatula (Fig. 35), hard-rubber or metal spoon (Figs. 29 and 39), or the like. The remains of these lenticular masses must, however, not be scraped out too energetically, because there is danger of injuring the cornea and espe-

cially of causing prolapse of the vitreous. Whatever can not be removed with this method without using undue force had better be allowed to remain. Such material often consists of sticky portions of the cortex, which adhere to the capsule and can only be driven out by using injudicious pressure; besides, they readily undergo absorption later, if the eye is not inflamed. Now that we are not afraid of making a large incision for the extraction, the stripping out of cataractous remains is not as important a matter as it was during the period when Gräfe's short incision was in vogue.

In concluding the operation the corners of the iris are once more inspected and, if necessary, the iris is once more replaced, and finally, the operative field is thoroughly cleansed of blood and the remains of the cataract. The blood, which is usually clotted and adheres to the wound in shreds, should be removed with the iris-forceps (Fig. 27). In doing so the operator sees that the conjunctival flap, if he has made one, is in the proper position and, if necessary, replaces it with the spatula; for the flap must not be turned back and lie in the wound at any point. The eye is then bandaged and the after-treatment, which will be mentioned again, begins.

Operation for Senile Cataract without Iridectomy.—This is also called the simple cataract operation, and the same instruments are required; for the iridectomy-forceps and scissors must always be ready at hand when this method is employed, because the operator is never certain that excision of the iris will not be necessary. A good many operators prefer to use a single speculum instead of the stop-speculum in this method of extracting the cataract, especially a Pellier (Fig. 32) or a Noyes speculum (Fig. 18), which take up less space. Or they merely ask the assistant to hold the lids apart with the fingers, protected with gauze. If a stop-speculum is used with this operation, the assistant must exercise great care to keep the blade under the upper lid slightly away from the globe whenever the patient tries to wink. This is

particularly necessary after the incision has been made, when the danger of prolapse of the vitreous begins.

If the stop-speculum is properly managed it is, according to my experience, practically impossible for the patient to produce prolapse of the vitreous by compressing the lids, both when iridectomy is used and when the cataract is extracted without iridectomy; it is even possible to use stop-specula which are held open by means of a screw (Figs. 9–13). If the assistant possesses the necessary skill he will, as a rule, have plenty of time to remove this instrument from the eye. Certain ingenious mechanisms have been devised in the construction of the instrument for the purpose of making it possible to remove it suddenly from the eye in case of threatening prolapse of the vitreous. Instead of a screw, Landolt has a small lever (Fig. 34) which can be pushed back and forth with the finger. This locks the speculum when it is dropped into a small ratchet, and allows it to open again when it is raised. Mellinger's (Fig. 13) and Koster's (Fig. 12) instruments are even more simple in their construction; for, while closure of the eyes is rendered impossible, although there is no stop-screw, the instrument can be at once closed and removed simply by compressing the handles and thus approximating the arms of the speculum. Unfortunately, these two specula sometimes draw the lids farther apart than is necessary.

In using a stop-speculum the assistant should stand on the same side of the patient as the eye to be operated upon; but if the lids are held apart with Pellier's hooks or with the fingers, the assistant should stand on the opposite side. In the former case his position is also the best in case an iridectomy becomes necessary. If the operator takes up his position on the patient's left side while he is operating on the left eye, the assistant must stand at the patient's head. This arrangement should also be adopted for extraction with iridectomy. The assistant should grasp the peripheral end of the speculum firmly with the thumb, second, and third fingers of the right hand, and keep it slightly away from the globe. At the same time he must take care not to hold it too far away; otherwise, if the lids are flaccid and long, the arms of the instrument may suddenly slip out from under them. As the arms are usually curved, the hand in which the speculum is held can be kept to one side of the patient's head so as not to interfere with the operator.

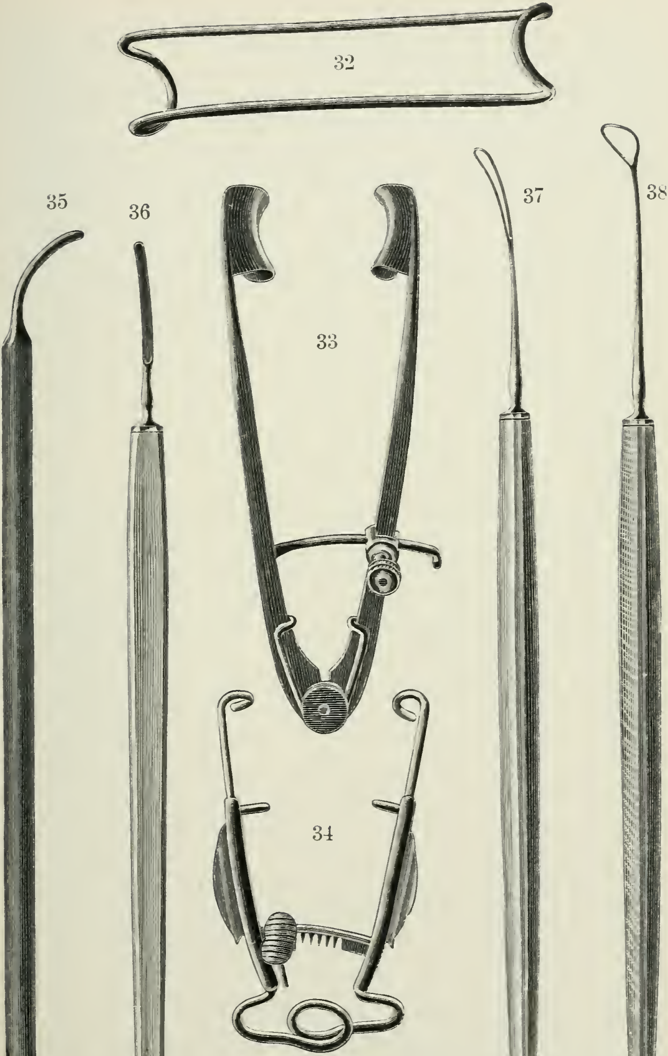
The simple operation is performed in the same way as when iridectomy is also used, except that the flap is made somewhat larger by inserting the instrument into the cornea and emerging again near the horizontal meridian of the membrane—*i. e.*, when the lens is extracted from above, a little deeper than shown in Plate 2. When this method is used, the cataract can, of course, also be extracted from below, and the latter method would be easier in the case of patients who find it hard to look down.

FIG. 32.—Pellier speculum.
FIG. 33.—Lang speculum.
FIG. 34.—Landolt speculum.
FIG. 35.—Pagenstecher glass spatula (manufactured by Müller, Wiesbaden).
FIG. 36.—Desmarres knife with a blunt point for the cataract incision.
FIG. 37.—Narrow wire-loop, after Snellen.
FIG. 38.—Broad wire-loop, after Weber.

But as one can never know for certain that an iridectomy will not be necessary, it is customary to make the incision above, because an upper incision is protected by the upper lid and during the period of healing is not quite so near the palpebral margin, which is never above the suspicion of infection.

The size of the flap must, however, be gauged more or less by the probable size of the nucleus and that of the cornea. If the latter is small, the flap must include one-half the membrane, the incision coinciding with the scleral border; if the cornea is large, or the nucleus which is to be expected is small, the base of the flap may be a little above the center of the pupil and the curved incision just within the corneal tissue. It is specially important and desirable when operating without iridectomy to make the wound rather too large than too small. For if the cataract escapes easily, without crushing the iris and forcing it into the wound, there is a reasonable expectation that no prolapse of the iris will take place.

After seizing the globe with the fixation-forceps near the lower border of the cornea (see Plate 2), the operator quickly makes a mental note of the point of entrance and exit for the knife. To impress these points on his mind, especially if he has not had a great deal of experienc, he should lay the cataract knife for an instant across the cornea so that the back of the knife is just in front of the horizontal diameter. He may also utilize this moment to make sure that the edge of the knife is directed upward and not downward, a mistake that is easily made, because the knife has such a narrow blade.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When a large flap incision of this kind is made the operator must be particularly careful to draw the knife backward and forward, and not exert too much pressure on the edge while completing his incision. Or he should follow the edge of the cornea, and keep as much as possible in the same plane of section, and when he reaches the upper margin he should cut a moderately large conjunctival flap. To do this the edge of the knife, instead of being turned sharply forward, is allowed to enter the sclera, and the incision continued a little longer, so that the edge emerges under the conjunctiva, which in old persons is not so firmly adherent to the sclera and, as a rule, is lifted up by the knife. It is then carried a little farther in the same direction, depending on the width of the flap which it is desired to make, and turned sharply upward so as quickly to divide the conjunctiva.

Most of the adherents of the simple extraction lay a great deal of stress on the conjunctival flap, on the ground that it favors rapid union of the wound and thus helps to prevent subsequent prolapse of the iris. Some operators also praise it as being a protection against infection. In my own opinion it is best not to place too much dependence upon its advantages, although it can not be denied that they are altogether lacking when a conjunctival flap is made; but any favorable influence it may have on the healing process should be regarded only as one of the factors in bringing about smooth recovery. A. von Gräfe, who also used this flap in his modified linear extraction, carefully investigated its value and advised against making a broad flap. Czermak's comprehensive critical review also shows that a broad conjunctival flap may interfere with rapid union of the corneoscleral edges of the wound; for the bridging of the tissue by the conjunctival flap destroys the marginal layer of epithelial cells, which, as we know, rapidly fills in the gap in a corneal or corneoscleral wound, and therefore materially aids in bringing about primary union. Instead, the marginal zone of epithelium lies farther back, at the edge of the flap. "At first, closure of the wound is effected solely by adhesion between the edges of this flap, until the combined corneoscleral wound has been closed by cicatricial tissue, which bridges it over and then contracts it; but the latter process does not begin until the fourth day." It is therefore better, if a conjunctival flap is to be used at all, not to make it more than 2 to 3 mm. wide.

After the cataract incision has been made, instead of doing an iridectomy, the operator at once opens the capsule with Gräfe's knife or some other cystotome, making

a thorough crucial or Y-shaped incision, at the same time being careful not to tear the zonule or displace the nucleus. [Peripheral opening of the capsule is preferred by some operators, as such a procedure lessens the danger of the formation of posterior synechiæ. Practically always a subsequent laceration of the capsule—discission—will be required.—Ed.]

After capsulotomy the cataract is delivered in the same way as in the operation with iridectomy, except that, as the cataract passes through the pupil, the iris is also pushed forward more or less; but unless it has been firmly pressed into the wound it usually drops back into its normal position, sometimes not without slight assistance with the spatula. If it fails to return, so that the pupil is no longer circular and is not at the right place, a delicate sound (Fig. 82) must be introduced into the wound, and the iris carefully freed and enabled completely to return to its normal position. If this attempt fails, and the pupil remains eccentrically displaced upward, it is better to make a secondary iridectomy.

As regards stripping out the cataractous remains surrounding the hard nucleus, it is best to do so rapidly and immediately after the escape of the nucleus, so that the iris will not remain long in the wound. Generally speaking this can not be done so thoroughly when no iridectomy is performed, because the iris gets in the way. If the remaining tissue is very small in amount it is better to leave it alone; if the fragments are large an attempt may be made to remove them with a Critchett scoop (Figs. 48 and 49); but if in the end any considerable quantity of material remains behind, it is better to do a secondary iridectomy, when the remains may be removed by expression or with the scoop.

Quite recently flushing the anterior chamber and capsular sac, which was in vogue during the eighteenth century, but was later given up again as being too dangerous (Guérin, 1773, see Magnus), has again been recommended as a painless and effective method of removing cataractous remains from the eye. M'Keown, Lippincott, Schiess, and Mellinger (according to Röthlisberger's and Erb's communications)

have recently given much attention to the technic of this method, using it in a considerable number of cataract operations. M'Keown's method was recently used by R. H. Elliott, in Madras, on 800 cases, and he warmly recommends it. In this method the irrigating fluid is contained in a glass bottle with a double bulb, and is forced through a short rubber tube into a glass point attached to the latter. In his book, M'Keown gives an accurate description of the method that developed, especially for the operation on unripe cataracts, and used in 148 cases. Lippincott reports 100 operations of this kind. He uses a glass irrigator, which is simply raised to get the action of gravity, the fluid being conducted through a glass point. In the 238 cases reported by Röthlisberger, Schiess used a Wicherkiewicz "undine," modified by Uhle; and, finally, Erb constructed a glass syringe, which has the advantage of being more readily sterilized. It is needless to say that these irrigating instruments must all be absolutely free from germs, a point insisted upon also by M'Keown. His apparatus, which may be obtained from John Clarke & Company, Belfast, Dublin, can also be completely sterilized by boiling. With regard to the fluids that may be employed in this method of irrigating the anterior chamber, it follows from what has been said on p. 69, that any solution in the least injurious to the tissues, particularly bichlorid of mercury, or carbolic acid, and the like, and even distilled water, must be avoided; for even distilled water is slightly injurious to the endothelium of Descemet's membrane. It has been found, however, as the result of accurate investigations made by Mellinger, and of innumerable clinical observations, that simple physiologic saline solution, or a 3 to 4 per cent. solution of boric acid is very well borne by the anterior chamber. All the authors cited agree that this method of flushing out the anterior chamber is the least injurious, and the best means of removing cataractous remains from the eye. It is also said to facilitate reposition of the iris, both after iridectomy and after operation without iridectomy. Irrigation may also be a great advantage in cases of traumatic cataract. Suction has also been employed for the removal of soft cataractous masses through a small corneal wound; this procedure is not free from danger, and may only be employed with a syringe that can be well sterilized, as for example, Lang's syringe, made for this special purpose by Bowman, and obtainable from Weiss in London.

Modifications of the Operation for Senile Cataract.—Modifications have been introduced at various stages of the operation for cataract extraction to insure a better subsequent course and a smoother recovery, as well as for the purpose of adapting one's self to individual variations, either in the eye or in the patient.

1. English operators in India, who practise largely on cataracts, among them Elliot and Pope, prefer to open the capsule before making the corneal incision. The capsule

is opened with Bowman's needles, which are inserted at the scleral margin in order to prevent as much as possible the escape of aqueous humor. They dwell on the advantage possessed by this procedure of enabling the operator to see accurately what he is doing, unhindered by any flow of blood, which often renders opening of the capsule difficult. At the same time this method enables the operator, before he makes the incision, to determine the structure of the cataract, the size of the nucleus, and the condition of the cortex, whether it be soft or flabby.

During a period covering a number of years I have occasionally employed this method in the case of juvenile cataracts in order to find out whether a small (line) or large (curved) incision would be required to remove the cataract, and it is quite true that in the case of senile cataract also the method does possess the advantages which have been claimed for it.

2. Some operators, particularly the French, open the capsule with the point of the knife as they carry it through the anterior chamber. This procedure has a certain value in cases in which it is desirable to terminate the operation as rapidly as possible.

3. Many operators prefer to tear out a piece in the pupillary region with the so-called capsule-forceps (Figs. 44 and 46) when they open the lens capsule. The instrument, which is very much like an iris-forceps, must be armed with teeth set obliquely and with the points downward. When the forceps is applied to the lens with gentle pressure, in the same way as when the iris is seized prior to iridectomy, the teeth bury themselves some distance in the tissue of the lens and, as the forceps is closed, the capsule is caught by the teeth and torn out and may be completely removed, so that afterward there is nothing left of the capsule and its epithelial cells in the pupillary region, and these structures can not, therefore, help to cause a secondary cataract.

This procedure requires a very steady hand and a pair of forceps of perfect workmanship, if it is to be carried

FIG. 39.—v. Gräfe cystotome with hard-rubber scoop.

FIG. 40.—v. Gräfe cystotome without the scoop, better than the above combination.

FIG. 41.—Cataract needle, without stop, for cystotomy, secondary cataract operations, etc.

FIG. 42.—Schweigger cystotome.

FIG. 43.—Cystotome of Weiss, London.

FIG. 44.—Wicherkiewicz capsule-forceps.

FIG. 45.—Couper capsule-forceps.

FIG. 46.—Treacher Collins capsule-forceps.

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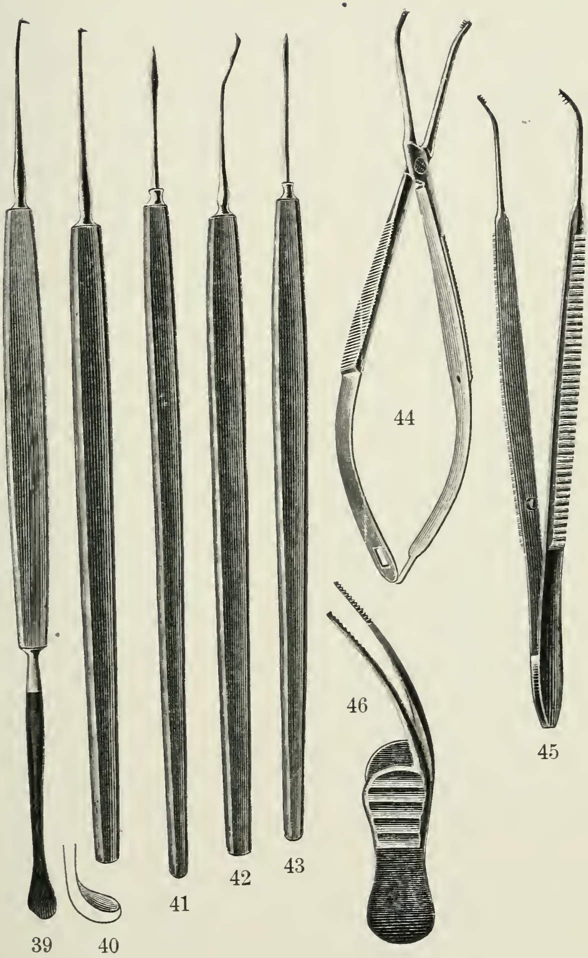
out correctly and without doing any damage; otherwise the zonule is apt to be torn and cause subsequent prolapse of the vitreous.

If the anterior capsule is thickened at the center, as occurs in cataracts that are somewhat over-ripe, the removal of the thickened portion may be a distinct advantage, if it can be effected without dislocating the entire lens. A more cautious procedure, however, is to make a circular incision around the thickened portion before lifting it out. For this procedure Snellen recommends a fine, round needle, the extreme point of which is bent over at an angle of 90°. With such an instrument he claims it is possible to scratch and divide the capsule in every direction, while Gräfe's cystotome permits the operator only to cut upward and downward. When Snellen uses this instrument to make the ordinary crucial incision for opening the capsule, he makes a vertical incision from above downward, so as not to displace the nucleus upward and thus draw it behind the wound.

When there is some difficulty about opening the capsule, because the cataract is over-ripe and shrunken and the thickened capsule adheres with abnormal tenacity to its contents, it is better to extract the cataract along with the capsule, and not attempt to open the latter at all.

4. *Extraction of the cataract with the capsule*, a method which has been chiefly developed and successfully used by A. and H. Pagenstecher, is specially adapted for over-ripe cataract, which possesses an atrophic zonule of Zinn (see p. 86), so that the cataract is apt to become separated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in toto from its suspensory ligament. Atrophy of the zonule is also observed in Morgagnian cataract and in cataracts that have already contracted. Dislocated and calcified cataracts are also best removed without opening the capsule.

Ordinarily, the fact of a cataract being over-ripe is recognized, aside from the possible presence of a capsular cataract, by the uniform gray or grayish-yellow cloudiness of the anterior cortical layer, it being impossible, even with oblique illumination, to make out any sharply defined markings.

The great advantage of this method of operating is that the entire lens is removed from the eye clean, without leaving any remains, while its disadvantage, which must not be overlooked, is that more or less vitreous is always lost; for such a loss is apt to occur, or at least threatens to occur, in most cases. By thorough cocainization this accident can, however, be confined within narrow limits. As this operation is never performed without at least opening the vitreous space, it is particularly important to make sure of as perfect asepsis as possible. The incision (according to A. Pagenstecher) must always be made at the corneoscleral margin, and the conjunctival flap must not be omitted. The incision must be just large enough to make it possible to remove the lens in the given case without any special difficulty; the smaller the better; but not too small and not larger than one-third of the circumference of the cornea. Cataracts that have a large amount of soft and semifluid cortical matter may be removed through smaller incisions than cataracts with a large firm nucleus (cataracta nigra). Iridectomy should always be performed, and the two edges of the iris section freed from the corners of the wound and replaced as shown in Plate 3. Pagenstecher's curet (Fig. 51) is introduced behind the upper border of the lens, at first in a vertical direction; the handle is then depressed, and the instrument carried forward a little farther, but never beyond the posterior pole of the lens. The assistant makes gentle

pressure on the lower border of the cornea with a glass spatula (Fig. 35), and gently and steadily pushes the lens upward until it presents in the wound.

This operation is not adapted to cases in which the tension of the vitreous body after the incision and the iridectomy continues high, nor when the patient is very restless.

5. Subconjunctival extraction, which was practised at the beginning, middle, and end of the last century by a few operators (Alexander, 1825; Desmarres, 1851; von Hasner, 1873; Pansier and Vacher, 1899), has been recommended lately by Czermak for cases in which there is danger of loss of the vitreous, either during the operation, owing to dementia, excitement, dislocation of the lens into the anterior chamber, over-ripeness, and the like; or after the operation from gaping of the wound (great restlessness, epilepsy, violent paroxysms of coughing, etc.). The procedure consists in making a broad conjunctival flap with the base above, which is not divided posteriorly, so that the edge of the corneal wound is connected with the equatorial conjunctiva by a broad bridge of conjunctival tissue. This makes it impossible for the wound to gape; at the same time, however, it is more difficult to excise the cataract under the conjunctival bridge. The latter should be made before the anterior chamber is incised, but, owing to the greater difficulty of extracting the cataract through an upper incision, iridectomy is absolutely indispensable. If it is desired to retain the circular form of the pupil, it is better to extract from below. In order to avoid, as much as possible, hemorrhage from the flap into the anterior chamber during the operation, adrenalin is first instilled into the eye.

6. Wenzel's operation is a very good procedure when the iris is adherent to the cataract (cataracta accreta), with or without inflammatory exudate formation behind the iris, and when there is anterior dislocation of the lens from glaucomatous increase of the intra-ocular tension, provided the other necessary conditions for operation are

FIG. 47.—A sickle-shaped cystotome and Daviel's scoop.

FIG. 48.—Bowman's scoop, rough at the point; and Critchett's, slightly bent over at the end, seen from the side.

FIG. 49.—The same instrument, front view.

FIG. 50.—Waldau's scoop.

FIG. 51.—Pagenstecher's scoop.

FIG. 52.—Weber's scoop.

The scoops shown in Figs. 48–51 are made of German silver; Weber's scoop is made of tortoise-shell.

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present. The cataract knife is inserted not only through the cornea but also through the iris, and carried behind the curtain; it is then brought out again through the iris and the cornea, the blade at the same time cutting the cataract, so that a curved incision is also made in the capsule, as the incision is completed in the usual way, either upward or downward. The iris is then excised as well as possible, just as in the case of an optical iridectomy. If the pupil is densely adherent, and a mass of exudate is also present behind the iris, it will be impossible to draw the membrane out of the anterior chamber, and the scissors will have to be introduced into the chamber. Wecker's scissors are useful for this purpose (Fig. 53). The cataract usually escapes without any difficulty.

Accidents and Mistakes in the Operation for Cataract.

1. When the conjunctiva is so friable in old persons that the tissue tears through every time it is seized with fixation-forceps, Pamard's spear (Fig. 19) or Schweigger's fixation-forceps may be used for steadying the globe.

2. In old persons with rigid sclera, especially when much cocain has been instilled, blood or air, or both, may enter the anterior chamber immediately after the incision (see p. 70). In itself this accident is of no great importance; but the blood may interfere with opening the anterior capsule, while a bubble of air, on the other hand, if anything, makes the opening of the capsule more distinct.

In this class of patients the delivery of the lens requires


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somewhat heavier pressure with the glass spatula or the spoon because intra-ocular tension is so low. After the lens has been delivered, the marked negative pressure, brought about by the diminution in the contents of the globe, causes depression of the cornea, which often forms a deep pit; but although it looks queer it is not followed by any bad consequences except that in such cases cataractous matter that has remained behind can not be stripped out, and must be allowed to stay or be flushed out. In these cases the first bandage must be applied somewhat more loosely, so as to allow the aqueous humor to collect again and bring the cornea back to its original position.

3. Several mistakes are possible in making the corneal incision. In the first place the knife may be held with the edge directed downward instead of upward as it is carried through the anterior chamber. If such a mistake has been made it is best to withdraw it rapidly, if possible without allowing the aqueous humor to escape, and reinsert it in the proper way through the first wound if possible, if not, alongside of it. In the second place the knife may be wielded with an excited and trembling hand as the incision is made, which is apt to cause premature escape of the aqueous humor and allow the iris to get in front of the knife. It is best under such circumstances to continue the incision quietly, cutting the iris at the same time, although, of course, the resulting iridectomy will be irregular or too small. That, however, can be remedied afterward with forceps and scissors.

A third and more serious mistake is to make the incision too small, especially when the nucleus is large. The incision in that case must be cautiously enlarged either with Desmarres' blunt-pointed knife (Fig. 36) or Wecker's (Fig. 53) or Stevens' scissors (Fig. 92). If a hard nucleus sticks fast in the wound it can be rolled out with a Gräfe's cystotome by hooking it into the side of the nucleus along the equator.

4. If the patient bears down while the incision is being made, the aqueous humor is rapidly forced into the wound

and brings the iris with it. In such a case the prolapsed portion of the iris is seized transversely—that is, in a line parallel to the corneal margin, gentle pressure being made on the iris while the iridectomy is being performed.

5. If, owing to abnormal toughness or thickening, the opening in the capsule turns out too small or can not be effected at all, which may also be due in part to a dull cystotome or interference with its action by blood getting into the anterior chamber and obscuring the field, the operator must carefully guard against trying to force the delivery by excessive pressure, as that would result in escape of the vitreous instead of the cataract. The thing to do is to take a cystotome and improve the opening. If the wound gapes during the attempt to deliver the lens, without any part of the cataract being seen, it should at once suggest that the capsule may not have been properly opened.

6. A more serious accident is failure of the nucleus to present in the wound, with the tendency to glide toward the upper ciliary body, an accident which has already been referred to for the purpose of illustrating the great importance of good illumination in cataract operation. As soon as it is noticed that the upper border of the nucleus fails to present in the wound, although cortical matter has escaped, this possibility must at once be thought of and lead to a careful examination of the state of affairs. This requires a very good light. With a cystotome the nucleus, if it has moved too far upward, may be pushed down again until the upper border is behind the wound, when quick, firm pressure on the lower border of the cornea will cause it to present in the wound.

7. A very grave and very important accident is prolapse of the vitreous. It should, by all means, be avoided, for it may have evil consequences not only immediately after the operation, in the form of opacities in the vitreous, infection of the vitreous and retinal detachment, but also at some later period. When there is myopia especially, retinal detachments may develop and end in blindness.

As a rule, prolapse of the vitreous injures the shape of the pupil, because it is impossible to replace the iris which has been forced into the wound. This gives rise to the disadvantages which have been discussed on p. 141. As a normal vitreous body, after prolapse, remains some time in the cataract wound, closure is delayed by from one to two weeks, and during all this time infection of the interior of the eye is possible. Fortunately every loss of vitreous is not followed by loss of eyesight or of the eye, especially when only the anterior portion of the vitreous, which occasionally is partially liquefied in cataractous eyes, escapes at the operation; but it should be an inviolable principle with an ophthalmic surgeon to leave the vitreous unhurt and untouched, whether the operation is performed for cataract or for any other purpose.

The appearance of the eye after an escape of vitreous at an operation for cataract differs according as the vitreous is normal or liquefied. In the former case it may be so watery as to be barely distiguishable from aqueous humor. Unless the operator is careful, a large quantity may escape during the operation, leaving the globe collapsed. This is, therefore, an important caution in the case of eyes in which the vitreous is probably liquefied (in myopia after iridochoroiditis). Liquefaction of the vitreous is recognized by the fact that it can be drawn out in threads. When normal vitreous escapes through the cataract wound, the edges are forced apart momentarily by the escape of a large transparent prolapse of a substance resembling fresh white of egg. The dark cavity of the interior of the eye shines through most uncannily in the depths of the transparent mass. If the proper thing is done and done at once—that is, the speculum removed, pressure on the eye diminished, and the patient quieted down—it may occasionally be possible to prevent the escape of normal vitreous after it has entered the wound. When the zonule is torn, however, or the hyaloid membrane has been split, it is the rule for a variable quantity to escape from the wound.

Prolapse of the vitreous may be favored or caused by some morbid condition of the eye or, rather, of the zonule, which may be atrophied or partially lacerated and therefore fail to prevent the escape of the vitreous. Abnormality of the zonule is specially apt to be present in extreme myopia, in over-ripe cataract, and after chronic uveitis and other varieties of degeneration of the vitreous. Sometimes the watery nature of the vitreous betrays itself before the operation by tremor of the lens during rapid movements of the eye. In non-congenital lateral dislocation of the lens and in pure luxation of the lens prolapse of the vitreous is almost unavoidable at the operation.

In the normal eye prolapse of the vitreous may be brought about by a faulty behavior on the part of the patient. At the slightest sensation of pain, and sometimes even when there is no pain, some patients compress the eye so that the contraction of the external muscles and of the lids forces the vitreous into the wound, even when the operation is faultlessly carried out.

Finally, a number of errors that are apt to be committed at the operation are capable of causing this unfortunate accident. The danger of excessive pressure with the fixation-forceps and wounding of the inner angle in this respect has already been referred to. When the opening in the capsule is insufficient, or no opening at all has been made, forcible manipulation for the purpose of expelling the lens may cause the vitreous to escape even before the lens. The accident most frequently occurs during and after the delivery of the cataract, while remains of the same or even some portions of the capsule are being removed. When this is attempted with the forceps, even though it be with the greatest caution, prolapse of the vitreous almost always ensues, hence the operator should never yield to the temptation of resorting to this procedure when he finds thickened pieces of capsule with or without adhering cortical matter. In regard to cataractous remains in general, the rule to expel and express only

what comes away readily and without too great expenditure of force should never be transgressed, nor should it be forgotten that the introduction of an instrument into the anterior chamber after the delivery of the cataract is always apt to be followed by injury and escape of the vitreous.

The earlier the prolapse of the vitreous takes place during the operation, the more complicated will be the situation and the more difficult will it be to finish the operation. If it appears immediately after incision of the globe, the iris, which has usually been carried into the wound, must at once be trimmed off with the scissors and a snare (wire loop) introduced to bring out the cataract, which otherwise sinks into the depths of the eye. During this procedure, which must be carried out as rapidly as possible, pressure on the bulb with the instrument or speculum must be avoided with the greatest care. The snare (Fig. 31) must be broad enough to take a firm hold of the cataract. It is introduced vertically around the upper edge of the cataract and the handle is depressed so as to seize the cataract from behind; the instrument is then carefully withdrawn, forcing the cataract slightly against the iris and cornea to prevent its escaping laterally from the loop. As soon as the cataract has been extracted the patient is told to close his eyes, and the bandage is applied. It is usually impossible to replace the iris, nor is the attempt to do so advisable, because it would only be attended by further escape of the vitreous. If the cataract sinks farther into the depths of the vitreous, and can not be removed with the snare, the operation should be suspended, the bandage applied, and the patient let alone until the next day, when there is a possibility of finding the cataract at its proper place and being able to remove it with the snare. As the necessity of using the snare may arise at any cataract operation with a flap-incision, it is always well to have the instrument ready at hand.

Often prolapse of the vitreous takes place because the cataract incision is too small and it requires too much force

to deliver the lens, thus endangering the integrity of the zonule.

The more peripheral the incision—that is, the farther away from the edge of the cornea—the greater will be the danger of prolapse of the vitreous when other favoring conditions are present. Hence, in operating on an eye in which prolapse of the vitreous is to be feared, the incision should lie entirely within the cornea.

Sometimes the way is paved for the escape of the vitreous by careless manipulation, causing injury to the zonule, especially by beginners; either excessive pressure upward may be made in applying the forceps for iridectomy, or the lens may be drawn from side to side and severely pressed upon during cystotomy. [If vitreous escapes after the lens has been extracted, the wound should be cleaned of protruding vitreous as gently and rapidly as possible and a bandage applied. If the escape of vitreous has been great, particularly if the vitreous is thin and there is a tendency for the eyeball to collapse, a tepid sterile physiologic salt solution should be injected into the vitreous chamber until the globe assumes its proper contour, as has been recommended (a recommendation which the editor can heartily endorse) by J. A. Andrews and H. Knapp.—Ed.]

8. The gravest complication during the operation is hemorrhage from the choroid. The patient feels a sudden agonizing pain, and a profuse hemorrhage takes place in the deeper layers of the eye, the rush of blood forcing the vitreous, retina, and choroid into the wound and partly through it, destroying the eye. This grave accident may not appear until after the operation, when it is recognized by the occurrence of severe pain and saturation of the dressings with blood. Immediate enucleation is the best plan in such cases.

[An attempt may be made to stop the hemorrhage without resort to enucleation: upright position, hypodermics of morphin, and full, firmly applied antiseptic dressing.—Ed.]

The best safeguards against the occurrence of a fatal hemorrhage of this kind are perfect rest after the operation, and, in the case of arteriosclerotic patients, measures to guard against sudden changes of pressure in the vascular system of the head and eye, as by cough and the like. Finally, in making the cataract incision the operator must be careful to cut slowly in order not to diminish the intraocular pressure too rapidly, and thus cause rupture of the vessels in the interior of the eye.

Method of Applying Dressing and After-treatment.

Whatever dressing may be used, and whether the eye is bandaged or not, the chief object under all circumstances is to induce as rapid union of the wound as possible, because it is the strongest precaution against secondary infection. Most ophthalmologists at the present time keep the operated eye bandaged at least for several days, and have the bandage changed every twenty-four hours. It is my custom to keep both eyes bandaged for twenty-four hours, changing the dressing once or twice, then to keep the operated eye bandaged day and night for from three to six days, and at night only for two weeks longer. For restless patients who, especially at night, are apt to injure the eye by rubbing or striking against it, Snellen's aluminum disc should be incorporated in the dressing, or a screen should be applied.

If no bandage is to be used the eye must at least be protected by a screen.

Twenty-four hours after the operation the eye should be examined; but in most cases inspection of the lower part of the cornea and the anterior chamber is sufficient, the wound remaining covered by the upper lid.

After an experience of many years H. Pagenstecher again recommends von Hoffmann's ichthyol dressing, and the excellent results he has obtained with that procedure speak strongly in its favor.

Pure ichthyol (from the Ichthyol Company, Cordes, Hermanni & Co., Hamburg) is spread on a piece of gauze

saturated with liquid paraffin, and laid on the eye. Both eyes are then covered with cotton, which is held in place by wire-screen spectacles to protect the eyes against injury. On the second, third, or fourth day the ichthyol dressing is removed from the eye that has been operated upon and only applied at night; this is kept up for several nights.

This dressing, with which I have also had practical experience for a year, and which I find very useful, is also justified on theoretic grounds. It has already been stated (p. 58) that the edges of the lids are most liable to cause infection, and should therefore be cleansed as scrupulously as possible. Both the ichthyol and the paraffin at least have the property of mechanically preventing any microbes that may happen to be on the edges of the lids from escaping into the conjunctival sac. It is also probable that the ichthyol has some disinfecting action.

Rest in bed should be insisted upon for at least twenty-four hours, and in most cases for several days, especially when the operation has been performed without iridectomy. In the latter case complete rest on the part of the patient is particularly necessary, and the eye must be protected against a blow or rubbing during the night; Knapp therefore advises that these patients should have their arms tied. To avoid chewing movements the diet should be liquid for the first three days. If iridectomy has been performed, however, the patient may, after the third day, spend the greater part of the day out of bed. The rule should be that the older the patient the shorter should be the period of confinement in bed, because otherwise the digestion suffers, with resultant loss of strength.

It is not advisable to discharge a patient who has been operated upon for cataract before the sixteenth day (see p. 44).

Accidents Interfering with the Healing of the Wound after Operations for Cataract.

Delayed closure of the wound and failure of the anterior chamber to regain its normal condition for several

days calls for careful bandaging of the eye without undue pressure, or simply the use of the screen. Delayed closure is observed chiefly in weak, ill-nourished and decrepit patients.

Iritis and iridocyclitis as sequels after an operation for cataract are less frequent than during the pre-anesthetic period. These conditions not only delay recovery and keep up the redness and irritation of the eye an abnormally long time, but may be the cause of true secondary cataract—that is, a more or less robust membrane in the pupillary region, formed by the posterior capsule, the remains of the anterior capsule, and inflammatory iritic exudate. Severe iritis may lead to the formation of a dense "plate," everywhere adherent to the pupillary margin.

An unpleasant complication is slow iridocyclitis with punctate deposits. Sometimes the latter are few in number; but when an eye that has been operated upon for cataract continues to present ciliary redness for more than three weeks, such deposits are usually found when the eye is carefully examined with a lens. The inflammation may last weeks and months, bringing with it the danger of sympathetic disease of the other eye. It probably depends on some form of infection, the exact nature of which is as yet unknown (see p. 66).

It requires careful supervision, atropin, great rest for the eyes and a subdued light, and if it fails to disappear under such treatment, and the introduction of an iodoform pencil into the anterior chamber also fails to bring about recovery, as I have often seen it do, enucleation is indicated.

[Dionin, in 1 to 5 per cent. solution, combined with atropin, is of great service in postoperative iritis. Internally, salicylates, in full doses, are useful, and, if the patient's constitution can bear it, diaphoretic doses of hydrochlorate of pilocarpin (gr. $\frac{1}{8}$ to $\frac{1}{4}$). Subconjunctival injections of saline solution and of cyanid of mercury are also to be considered.—Ed.]

Such patients, with slightly reddened eyes, deposits on the posterior wall of the cornea, and a tendency to lacrimation, are just the ones who are apt to return with sympathetic disease of the other eye, if the surgeon yields to their importunities and allows them to go home before the eye has become completely quiescent and white. Sympathetic disease after operation for cataract has also become less frequent during recent decades; but whenever the operation causes cyclitis, especially if the wound extends into the scleral border, the possibility of that horrible disease attacking the other eye must be borne in mind.

Purulent infection of the eye during and after the operation for cataract is a very grave complication and, as a rule, very difficult to combat successfully. It may lead to purulent infiltration of the edges of the wound and diffuse cloudy discoloration of the cornea within twenty-four hours after the operation and, as a rule, goes on irresistibly to total purulent infiltration and breaking down of the cornea, with more or less inflammatory edema of the bulbar conjunctiva. Often the inflammation spreads rapidly into the deeper layers and causes protrusion of the globe and ultimately panophthalmia.

A purulent infection may develop after the first day and, in fact, at any time until the wound is firmly closed; but it is most to be feared on the first and second days. As it is usually heralded by pain, it is absolutely necessary to examine the eye at once if the patient complains, as the process may possibly be arrested or at least kept within bounds if discovered at the very beginning. The eye must then be disinfected in the manner previously described (see p. 68).

A harmless accident after an operation for cataract is the draining of the aqueous humor underneath the choroid after the wound has healed and the anterior chamber has been restored. The latter suddenly becomes shallow, and when the interior of the eye is examined, the choroid is discovered as a tumor-like prominence of grayish or grayish-brown color, protruding into the aqueous and forming a pseudotumor, which, however, need not alarm the surgeon. Fuchs has observed a comparatively large number of cases in which the aqueous humor

Plate 4.

Operation for secondary cataract, after Bowman, with two needles.

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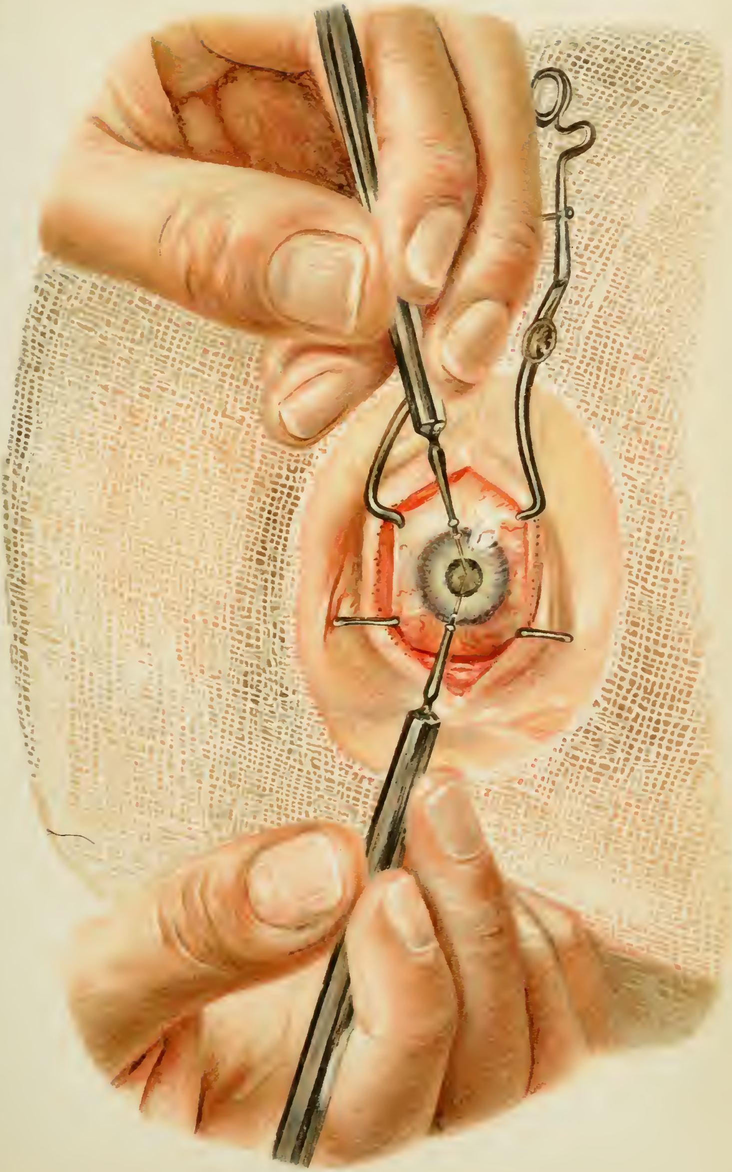
escaped in this way without producing any harm. The fluid makes its way through a tear in the root of the iris.

Glaucoma is a most unpleasant, although, fortunately, not very frequent, complication after operations for cataract. Since we know, that when the cataract wound is slow to close the epithelium of the cornea and of the conjunctiva may proliferate into the anterior chamber and form a complete lining for it as well as for the iris and the angles of the chamber, we understand why glaucoma after the operation for cataract sometimes defies every form of treatment.

Occasionally something else besides iritis and deposits on the cornea is the cause of protracted reddening and irritation of the eye; it may be a capillary fistula in the scar of the wound. This also is usually due to delayed healing of the wound, the epithelium in places bridging over the wound-edges and thus making it possible for a small fistula of the anterior chamber to develop. The eye under such circumstances often frightens a surgeon, because of the minus pressure which suggests a cyclitis. On examining the scar and at the same time exerting a gentle pressure on the eye, a little fluid will be seen to work out at a certain spot. As a rule cauterization with the galvanocautery is speedily followed by recovery.

Operation for Secondary Cataract.

Since the introduction of modern methods of treating wounds, this operation, which was formerly a much-dreaded one, in spite of its apparently trifling character, is, when properly performed, practically harmless and at the same time a most satisfactory procedure. In many cases vision is not permanently restored until it has been performed. Its object is to perforate the membrane which remains behind in the pupillary region after a cataract operation, or makes its appearance later, becomes thickened and interferes with vision, so that the center of the pupil finally is freed of everything capable of obstructing the light. Even the posterior capsule alone, if it forms wrinkles or possesses or develops areas of thickening, may prove a serious obstacle to vision, and, if to this are superadded remains of the anterior capsule, epithelial proliferations of the latter, causing still further thickening, and remains of cortical material, the result is often a continuous, thin, grayish membrane, which may easily reduce



vision to $\frac{1}{4}$ or $\frac{1}{6}$, even when there is no inflammation in the case. If the operation is followed by iritis, the secondary cataract may be even thicker.

In myopic individuals more or less secondary cataract is the rule.

The persistence of large remains of cortical matter does not always produce a secondary cataract. A very clear pupil may be formed in spite of them, even though it takes some time, provided only there is no inflammation. This is probably explained by the fact that the cortical remains keep the anterior capsule and its proliferating capsular cells away from the posterior capsule for some time and hold the edges of the tear in the anterior chamber apart, so that the capsular cells are unable to form deposits on the posterior capsule, and after the remains have been absorbed the posterior capsule remains perfectly clean.

The indication for discission of a secondary cataract or of a wrinkled posterior capsule depends on the accuracy of vision that is necessary in any individual case. If the patient's work is such as to require accurate vision, a secondary one will be necessary, even if he has a visual acuity of one-half.

When a cataract operation is followed by a normal recovery, the one for secondary cataract may be undertaken as early as two or three weeks later. It is better to avoid delay, because even a thin secondary membrane becomes more rigid and harder with time. It is therefore easier to divide them ~~early~~, especially if the finest portion of the membrane is selected for discission. However, the eye ought to have lost every sign of redness before it is attempted, and the general rule which has been given above, that inflamed eyes must not be operated upon, applies particularly to these cases, barring only the exceptions noted on p. 68.

Discission of a secondary cataract can be performed equally well four to eight weeks after the primary one.

In this operation it is always to be remembered that it is free from danger only when strict antiseptic precautions

Figs. 53–59.—Instruments for secondary cataract operation.
Fig. 53.—von Wecker's scissors-forceps.
Fig. 54.—Desmarres' capsule-forceps.
Fig. 55.—Desmarres' capsule-forceps, modified by Lüer.
Fig. 56.—Bowman's discission-needle.
Fig. 57.—Knapp's capsule-knife.
Fig. 58.—Knapp's capsule-knife.
Fig. 59.—Weiss' cataract needle with one cutting edge.

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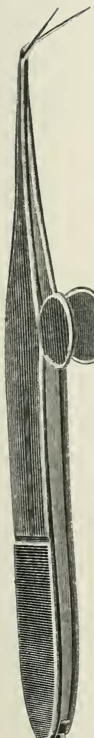
are observed. Formerly it was almost as dangerous as the cataract operation itself. Surgeons did not like to resort to it because it was also apt to be followed by severe purulent inflammation and sympathetic disease of the other eye. In fact, a case was reported recently in which, in spite of modern antiseptic precautions—although it was in a walking patient—the eye was lost through panophthalmia.

It follows, therefore, that the eye must be prepared quite as carefully for a secondary, as for a primary cataract operation. It is also advisable, before entering the anterior chamber, to flood the operative field with a 1 : 5000 solution of bichlorid of mercury, so that the needle or needling knife makes its way through a thin layer of the antiseptic fluid. It is also important not to touch anything with the needle first (Fig. 1).

The small puncture will heal more quickly if it is placed under the conjunctiva, at the scleral border, after the method of Kuhnt, because it is in a vascular tissue and there is less danger of the wound filling with vitreous. A prolapse of the vitreous into the wound may also take place in this operation if the wound is in the cornea, even though it be a small one. For the vitreous material protrudes through the wound like thread, at first clear, and later of a grayish color, and endangers and interferes with recovery. It forms a bridge by which infection may reach the interior of the eye. At the best it delays healing and annoys the patient by the irritation that is set up. Sometimes these threads consist merely of the so-called filamentous keratitis, a less dangerous but equally tedious complication. A poor needle—as, for example, one of the wrong width (see Fig.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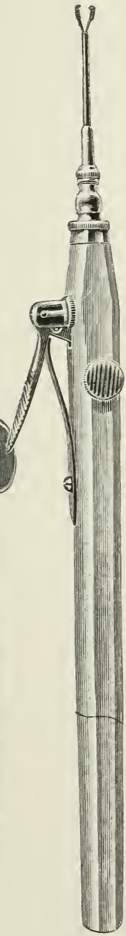
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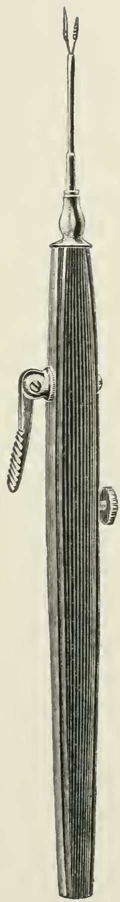
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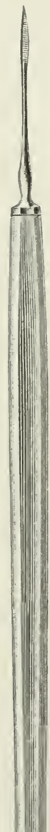
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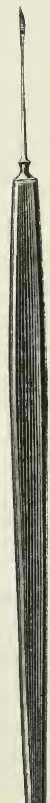
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6, *b*)—favors the occurrence of prolapse of the vitreous. Needles that have been ground too often, and have therefore become too narrow at the cutting edge, also predispose to this accident, because, as the needle advances, the handle also pushes the wound edges apart and makes a roundish hole, which is slow to close and sometimes permits the vitreous to escape. Needling knives that are not of the proper construction may produce similar results.

Instruments suitable for this purpose are sharp discission needles of various shapes (Figs. 41, 43, 56), or needling knives as designed by Knapp (Figs. 57, 58) and Kuhnt (like Knapp's instruments, but bent over).

With good instruments of this kind it is also possible to enter the cornea (Knapp) and in that way attain more freedom of movement with the instrument.

The steps of the operation depend on the kind of secondary cataract present. First of all, the eye must be carefully examined under good lateral illumination with the magnifying lens to determine the nature of the cataract and the location of the blackest, that is, the thinnest, spots. The spots which lie nearest the center of the pupil are first utilized for making the opening.

A bright light is indispensable for the proper performance of a secondary cataract operation; electric light is the best.

The eye, having been dilated with atropin and cocainized and the speculum introduced, the globe is seized with the fixation-forceps opposite the point where the needle or knife is to be introduced at the scleral border. This spot is chosen where the introduction of the blade will most easily enable the operator to make a free incision in the membrane with the first movement of his hand, as indicated by the arrow in Fig. 3. The needle or knife is introduced at a point 2 to 3 mm. from the corneal border, through the conjunctiva and sclera, into the anterior chamber, so that the instrument enters just in front of the iris, and is introduced along the iris until the desired thin spot in the secondary cataract has been reached (see Plate 5).

After the first incision has been completed, a second one is made vertically or obliquely to the first, either by rotating the needle or knife through 90° around its long axis, or by introducing it a second time at some other appropriate point on the scleral border. It is better not to attempt to divide thick areas and threads and cords in a secondary cataract, because the attempt is usually not successful with this method. The instruments should never be thrust deep into the vitreous body. No aqueous humor should escape—an accident which can readily be avoided with this method of introducing the instrument if the needle or the knife has a good point and a good edge.

When the secondary cataract is somewhat thicker and does not present any thin areas, the capsule-knife is introduced more nearly at a right angle—*i. e.*, through the cornea about 2 to 3 mm. from the border; the operation is then completed in a similar manner, the edge of the knife being brought into action as much as possible. Or the operation may be performed with two needles, after Bowman, which is more a lacerating than a cutting procedure. According to my experience this operation, which, until recently, I used almost exclusively, or at least in a large number of cases, has many advantages and, if properly performed, is quite free from danger to the eye. Correct technic consists in introducing the two needles as shown in Plate 4, one after the other or at the same time, at a point about 2 to 3 mm. from the corneal border and at directly opposite points, and bringing them out again through the secondary cataract at the same point in the center of the pupil. By separating the points of the needles with a symmetrical movement, a short horizontal tear is effected without the traction being communicated to the periphery; the tear is then increased in a vertical direction by separating the points of the needles from one another from above downward. The two movements may have to be repeated once more with somewhat larger excursions, and, as a rule, the resulting gap is then large enough, even if the secondary cataract is quite thick and

rigid. It is even possible with the needling operation to divide any small cords that may accidentally be found at the center of the cataract. This is done by crossing the needles slightly as they are introduced into the membrane.

When a thickened portion is found at the center of an otherwise rather thin secondary cataract, it can be removed with Desmarres' specially constructed capsule-forceps (Fig. 54) or with Lüer's modification of the instrument (Fig. 55). A Gräfe knife or some other narrow-bladed knife (Figs. 76 and 78) is introduced through the cornea or even, if there is an appropriate spot, directly through the secondary cataract, which is then seized with a small capsule-forceps. The instrument shown in Fig. 55 may also be thrust directly through both the cornea and the secondary cataract. The method is somewhat more radical than those mentioned above, but it can nevertheless be employed without doing any injury to the vitreous or causing it to enter the corneal wound.

When the secondary cataract consists of thick, complicated masses of tissue everywhere adherent to the pupil, or when there has been complete upward displacement of the pupil after a bad recovery, and the iris is usually covered on the posterior aspect with a membrane consisting of inflammatory exudate and masses of secondary cataract, it is often a very difficult task to make an opening in this diaphragm. After traumatic cataract, when convalescence has been complicated with inflammation and after complete distortion of the pupil, we often find ourselves in the same predicament.

The most important rule is not to operate until the eye has been free from inflammation for from six months to one year, as otherwise the operative wound closes again in a very short time.

The least severe operation in these cases consists in the following procedure: Two of Bowman's needles are introduced, one after the other, from the temporal side, through the cornea and iris, near the edge of the former, parallel to each other and 3 mm. apart, and the two needles are then advanced almost to the other side of the iris. The needles are then held by an assistant, who at the same time fixes the globe with the forceps. Their purpose is to prevent the thickened iris from slipping backward as

the diaphragm is divided between the two needles. To accomplish this a Knapp's capsule-knife is introduced opposite the points where the needles have entered—that is to say, near the nasal edge of the cornea and in the horizontal meridian, introducing it into the anterior chamber almost as far as the point of entrance of the two needles. The edge is then directed backward, and the iris divided as completely as possible between the needles. As a rule, the incision becomes sufficiently stretched by the prolapsing vitreous body. No vitreous is lost in this procedure because only three small punctures are made.

A more radical operation, because combined with more or less escape of the vitreous, and a more useful one for many cases, is that of de Wecker, which is performed with the excellent scissors-forceps (Fig. 53) designed by him. With a narrow keratome or knife, as in the case of linear extraction, access to the iris is obtained, and at the same time the knife is also introduced into the thickened iris. The corneal incision should only be large enough to permit of the introduction of the closed scissors-forceps. The scissors are then opened in the anterior chamber; one of the blades introduced through the wound and placed behind the membrane consisting of secondary cataract and iris, while the other blade is pushed as far in front of the iris as possible, when the intervening tissues are divided with one snip, leaving a widely gaping cleft. If necessary, a second incision can be made so as to form a V-shaped wound. The remaining tag usually retracts.

A variety of other methods have been recommended for the excision of pieces from the center of an iris complicated by thickenings of the capsule, but the loss of vitreous at the operation is sometimes greater than is quite justifiable. Not infrequently the loss of vitreous is too great, even with the small incision necessary for the introduction of Wecker's scissors.

Dressing and after-treatment must be as scrupulously attended to after an operation for secondary cataract as after a primary operation.

Treatment of Operation for Senile Cataract by Couching and Depression.

These antiquated methods, which were practised before cataract extraction came into vogue, are not used by scientific physicians except in very rare cases. In India, on the other hand, and possibly among other distant peoples, the method is still practised by the native lay doctors. For reasons referred to previously (p. 118) the procedure ends in failure in 40 per cent. of the cases. It might possibly be indicated when the vitreous is liquefied, especially in cases of marked myopia when a corneal incision would cause the escape of almost all of the vitreous, which would be followed by a retinal detachment. In such a case couching, with scleroticonyxis—that is, puncture through the sclera—may be advisable, as the operation through the cornea (keratonyxis) is more difficult and less reliable. According to Scarpa's method the operation consists in turning the cataract over backward and upward with a couching needle (resembling the needle shown in Fig. 41, except that it is bent on the flat). The eye having been prepared in the same way as for a cataract operation, the globe is seized with a fixation-forceps, immediately under the cornea, and steadied while the needle is introduced into the sclera 3 to 4 mm. from the corneal margin and slightly underneath the horizontal meridian, as though it were to be carried toward the center of the vitreous. The edge of the needle should lie in the horizontal plane, the convex surface directed upward. After the needle has penetrated the globe to a distance of about 0.5 cm., it is rotated around its axis until the convex surface is directed forward. The point is now directed forward and pushed in between the iris and the lens. After it has entered the pupil as far as the pupillary margin of the opposite side, the shaft of the needle is elevated in front, thus imparting a lever-like action to the needle and depressing the lens downward and outward. The cataract must be maintained for a few moments in this new position until it becomes completely surrounded by the vitreous, after

which the needle is withdrawn in the same way as it was introduced.

The cataract may rise again and return to its original position. If it is soft, it usually breaks up without being depressed. As a rule the capsule is opened in this procedure. Sometimes the cataract would get into the anterior chamber. The operation is not such a very simple one. Depression—that is, pushing the cataract directly downward—is still less to be recommended.

The Operative Treatment of Dislocation of the Lens.

The lens, whether clear or cloudy, may be dislocated spontaneously, especially in myopic eyes and after chronic iridochoroiditis, or as a result of traumatism—a blow or a fall and the like. The dislocation takes place either into the vitreous or into the anterior chamber, and is due to atrophy or laceration of the zonule of Zinn. In either case the dislocation is apt to produce glaucoma. The operative removal of a dislocated lens from the eye is a most precarious and ungrateful undertaking for the surgeon, and should not be resorted to until after rest, miotics, etc., have failed to bring about the desired result. For, as the lens has become loosened from its suspensory ligament, its removal is always followed by the escape of much vitreous and its evil consequences, even though the operation be performed under anesthesia. It is to be remembered that in dislocation of the lens into the vitreous it is often very difficult to get a firm hold of the lens with a snare and to remove it rapidly. It is apt to slip to one side and escape from the snare. In any case the corneal incision must be large enough, otherwise the lens can not be removed from the globe at all.

When dislocation of the lens is the result of inflammatory degeneration, it is best to enucleate the eye, because recovery after extraction of the lens is doubtful, and the operation is apt to produce sympathetic disease of the other eye. In fact, I have seen that develop after extraction of the lens in the case of traumatic dislocation.

Plate 5.

Operation for secondary cataract with Knapp's knife introduced through the sclera.

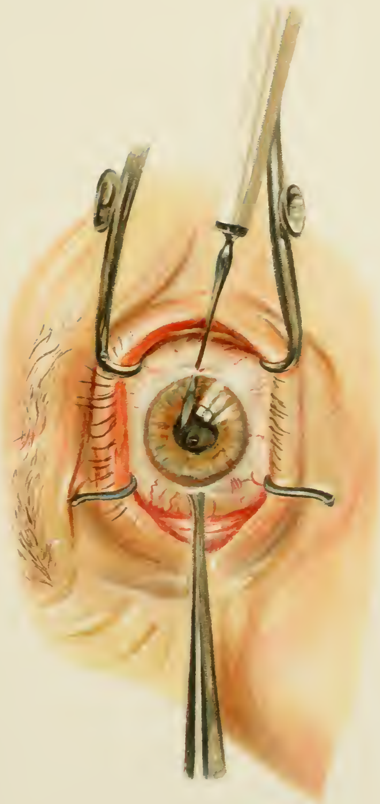
In partial dislocation, when the lens is merely displaced to one side and is still held by the zonule of Zinn on the other, discission is the best operation, especially in youthful patients. If the operation is performed with skill, it is usually possible to spear the lens with one of the discission-needles, and tear the capsule with the other needle, making only a moderately large opening, so that the swelling of the lens will not be too great and the prolapsing mass of lenticular material is at once absorbed. Puncture of the cornea must be avoided in such cases, because it would be followed by immediate prolapse of the vitreous. If absorption is interrupted a needle is introduced into the opening in the capsule, and the lenticular substance stirred up, or the opening may be enlarged with both needles. Increased intra-ocular tension is treated with rest in bed and miotics.

Although this method is somewhat slow, it is reliable and yields beautiful results. It is also suitable for cases of congenital ectopia of the lens in young persons, when the tremor of the lens is so great as to increase the intra-ocular tension or threaten dislocation. According to my experience extraction of the lens in these cases is less advisable.

Removal of the Lens in Cases of High Myopia.

It was pointed out by Beer, in 1817, and by Mauthner, in 1876, as well as by others, that a very high grade of myopia can be improved by removing the lens. The relief thus effected is more urgently indicated, as it is impossible to wear glasses strong enough to secure good vision, because the eyes will not tolerate them.

The operation for myopia was first performed by Ad. Weber in 1858, but was not accepted by the operators of his time, chiefly on the ground of its danger, and, indeed,



it was quite right to put it off until our own time. It needs the extra precaution of antisepsis and asepsis to justify this grave interference in cases which for years have been regarded as dubious from the operative point of view, and which formerly were quite rightly regarded as *noli me tangere*. Fukala returned to the method thirty years after Weber's time, and wrote about it in 1889. He was followed soon after by Vacher, in France. The operation has been taken up with great enthusiasm, perhaps with excessive enthusiasm. On the strength of my own experience with 100 operations of this kind I feel impelled to counsel caution, not only in the operation itself but also in the selection of cases. It is not true that disease of the macula, which is such a serious menace to the eyesight, does not occur after this operation, or is brought to a standstill. If such eyes are used, macular disease often develops, and is quite as severe as in eyes that have not been operated upon. The more intellectual among these patients, who wish to make extensive use of their improved vision, often live to be cruelly disappointed, either because the eyesight again becomes irreparably impaired, or the physician keeps on repeating the old caution against excessive use of the eyes.

It is also probable that those who have been operated upon for myopia are in greater danger of having a retinal detachment than those who have not. Unless the entrance of vitreous into the wound during the operation is scrupulously avoided—which requires the greatest care—or if the vitreous is injured at the final discission of the posterior capsule, the predisposing factors for a retinal detachment are furnished. It is not right to assume, when a retinal detachment does not occur until one or two years later, that it can not be due to the operation. Moderate or very slight injuries to the vitreous are often followed by a retinal detachment many years later.

Since the primary failures alone with this operation in the hands of individual operators amount to 10 to 14 per cent., which does not include subsequent deterioration or

loss of vision, the greatest caution is absolutely indispensable. It is much more important in this operation than in any other to prevent the entrance of vitreous into the wound, whether the latter be large or small. Individuals with high myopia are naturally prone to retinal detachment. In the second place infection of any kind must be scrupulously guarded against. Finally, unless the operation is correctly performed in every particular, such eyes are exposed to the danger of severe glaucoma, and the literature shows that many an eye has become blind from that cause.

To escape the patient's reproaches and a great deal of trouble the operator should select only cases in which the macula is still in a fairly good condition, the myopia 20 D. or more, and the patient young. Moreover, he should choose the method of operating with which he is least likely to see anything of the vitreous—that is, discission—and make as small a puncture of the anterior chamber as he can get along with. In children discission alone and absorption suffice. It is better, if possible, to omit the final discission of the posterior capsule; at least it should never be done earlier than six months after the operation and after the eye has had complete rest and is free from irritation.

Scrupulous care and the strongest possible light are indispensable, even for the first discission of the anterior capsule, in order to guard against laceration of the zonule.

Such eyes naturally possess a weakened, delicate zonule, which may quite easily be injured at the first opening of the capsule. If the zonule tears, the initial puncture or linear extraction will be attended by the entrance of vitreous into the wound, and the evacuation of the cataractous masses must at once be interrupted. The cataract continues to swell, the tension is increased, a second puncture is required, vitreous again escapes with but a small quantity of lenticular substance, and the condition ends in glaucoma, with which the surgeon will have to

contend for months without satisfactory treatment and without success.

It therefore follows that, when the capsule is first opened, the lens must not be pulled to and fro even the width of a hair, nor pushed backward.

In order to evacuate a swollen lenticular mass after the discission, a fairly large corneal incision is necessary; for when the lens is not cloudy the cataractous masses are exceedingly tenacious.

Some operators prefer to remove a clear lens, even in youthful individuals, by the same operation as that which is employed for senile cataract—that is to say, a large incision at the corneal border, opening of the anterior chamber without preliminary iridectomy, and expression of the lens. The ultimate effects of this procedure have not been reported in sufficient numbers to make it possible to form a judgment, but it can not help being followed more frequently by injury of the vitreous than cautious discission.

In most cases it is advisable to operate only on one eye, so that the other eye will at least be useful for near-sight and, in case of accident, the patient does not become totally blind.

The man who operates on a myopia of less than 15 D. brings the method into ill-repute. The patients simply exchange their minus glass for far-sight for a plus glass of equal strength, and lose their good near-vision without spectacles, of which they are often quite proud. After the operation they have to wear a heavy cataract lens of 8 D. or more for near work.

II. IRIDECTOMY.

Iridectomy as an independent operation is performed chiefly for two reasons. First, as optical iridectomy to afford the rays of light access into the interior of the eye when the normal pupil is displaced laterally or anteriorly by inflammatory exudate or distortion, or completely cov-

FIGS. 60–66.—Instruments for iridectomy.

FIG. 60.—Von Gräfe's stop-speculum.

FIG. 61.—Curved keratome, seen from above.

FIG. 62.—Curved keratome, seen from the side.

FIG. 63.—Fixation-forceps.

FIG. 64.—Curved iridectomy-scissors.

FIG. 65.—Iris-forceps.

FIG. 66.—Spatula for replacing the iris.

Of course, instead of these instruments, others that serve the same purpose may be used.

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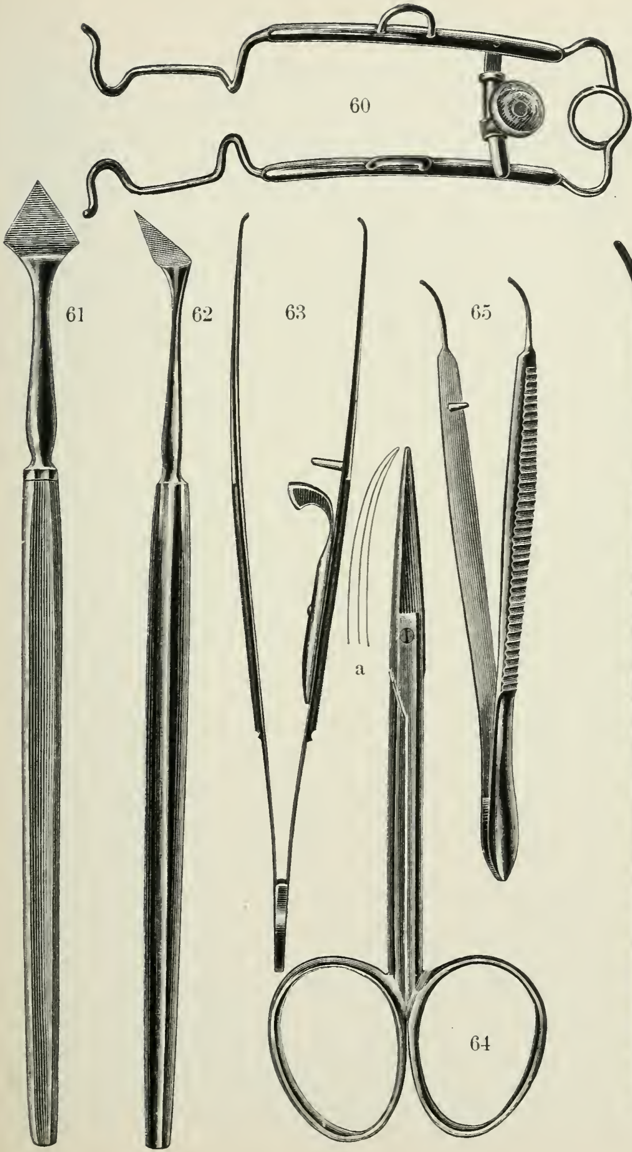
ered by a thick central corneal opacity. The operation may also be considered when there is a stationary central opacity of the lens (see p. 112). Second, another and much more important reason for performing iridectomy is to reduce morbidly increased intra-ocular tension in glaucoma.

1. Optical Iridectomy.

This operation, which originated in the eighteenth century, is now, as a rule, performed after the manner proposed by Beer at the beginning of the nineteenth century.

The value of the newly formed pupil is often greatly diminished by the fact that the lateral portions of the cornea and of the lens, which correspond to the new pupil, are not possessed of as equally good refracting power as the central portion. The more peripheral the location of the new pupil the less distinct will be the retinal image that it makes possible; although its distinctness may be increased by means of a cylindric lens. Hence, the optical result of the measure is, as a rule, most satisfactory when the pupil has to be only slightly displaced to one side, for which purpose it is enough to cut a small piece out of the iris near the pupil.

It must never be forgotten that iridectomy, unless it is covered by the upper lid, may distress the patient by admitting too much light, especially in cases of corneal opacity. For, if the pupil is not adherent to the lens, and therefore possesses its normal mobility—as, for example, when iridectomy is performed solely on account of a corneal opacity—the pupil will remain permanently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dilated, because a piece of the sphincter has been removed, and the normal power of contraction has therefore been impaired. Corneal opacities often produce marked blinding, because they act like a ground-glass and diffuse the light into the eye. The annoyance is, of course, greater in proportion to the size of the pupil and the degree of translucency of the opacities. In such cases it is sometimes necessary to blacken the central corneal opacity by tattooing, in order to diminish the patient's discomfort.

It is altogether wrong to make an optical coloboma behind an opaque cornea, even when the opacity is only slight. The vision is not materially improved thereby, while the patient is annoyed by the troublesome blinding effect.

If optical iridectomy is to accomplish its purpose, it must be wholly or at least partly within the region of the palpebral fissure. If the greater part of the cornea is opaque, the location of the iridectomy will, of course, have to be determined by the remaining clear tissue. A clear spot may be tested for the remaining degree of function by dilating the pupil and holding a disc of lead with a slit in it in front of the eye, in various meridians, until the position is found where vision is best, which will correspond to the most favorable corneal meridian. Sometimes it may be necessary to give the patient a convex or concave lens in performing the test. The iridectomy should then be placed in this meridian, care being observed to excise a narrow piece of the curtain, so that the opening will be cleft-like in form. A diaphragm with a small and narrow opening yields more distinct images than one with a large opening.

The instruments necessary for this form of iridectomy are shown in Figs. 60–66.

After the eye has been well cleansed and cocainized, the speculum is introduced, and the operation is usually performed with a narrow, or only moderately broad, curved keratome (Figs. 61 and 62). In cutting, the operator may carry the instrument away from his body,

or he may carry it toward it; but in the latter case he will have to change his position with relation to the patient. For example, in doing an iridectomy on the left eye at the inner and lower angle, which is often selected for optical iridectomy, the operator, if he wishes to cut toward his body, stands to the right side of the patient; and if he wishes to cut away from his body, to the left of the patient. For excising a small segment of the iris, the knives shown in Figs. 76 and 78 may also be used to advantage. With these instruments a small wound is made in the cornea which, however, must not be too narrow on the side toward the anterior chamber, so that there may not be much difference between the inner and the outer wound. It should also be remembered that instead of an iris-forceps (Fig. 65) a blunt iris-hook (Figs. 67 and 68) is also quite useful in optical iridectomy, especially when it is desired to seize only a small piece near the pupil. It requires only a small incision in the cornea to introduce the hook into the anterior chamber, and, as it is blunt, there is no danger of injuring the lens. Besides, seizing the iris with the hook is a painless procedure (Axenfeld), which makes it easier to place the iridectomy correctly. The instrument is introduced flat over the iris, then slightly rotated to seize the edge of the pupil, and drawn out again flat. It has the advantage of permitting the incision to be made at the limbus of the sclera, leaving the cornea free from any incision, and therefore obviating any danger of a consequent permanent opacity, which sometimes partially interferes with the newly formed coloboma.

The globe is fixed opposite the point where the keratome is introduced. After the assistant has taken charge of the fixation-forceps, the operator introduces the finely serrated iridectomy-forceps (closed), seizes the iris near the edge of the pupil, draws it out in front of the wound, and snips off the fragment with the bent iridectomy-scissors. When a narrow iridectomy is desired, the iris, after it has been drawn out through the wound, is excised in a radial

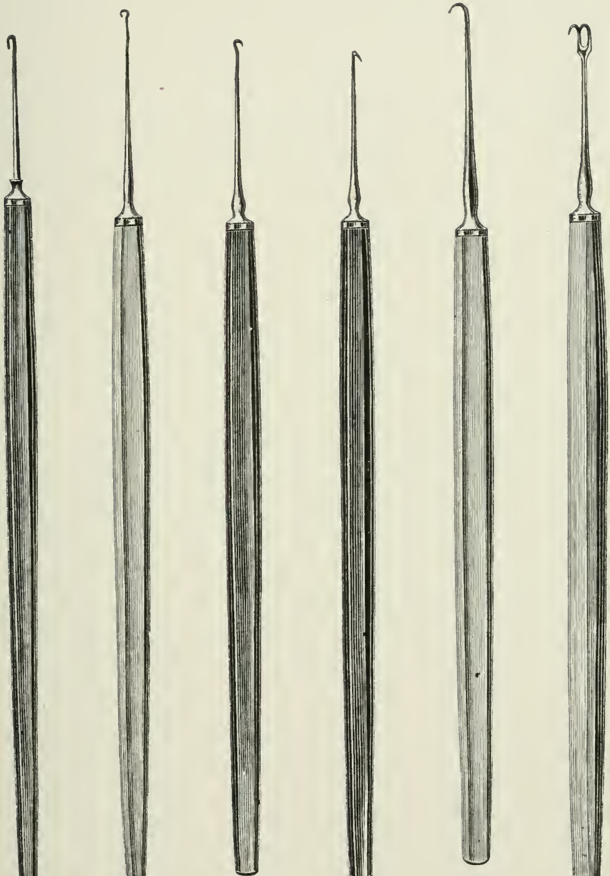
FIG. 67.—Blunt iris-hook.
FIG. 68.—Blunt iris-hook.
FIG. 69.—Sharp iris-hook.
FIG. 70.—Sharp iris-hook.
FIG. 71.—Single hook.
FIG. 72.—Double hook.

direction. If, on the other hand, it is desired to have the coloboma reach as far as the periphery, the curtain is cut off along a line parallel to the wound. Instead of the usual iridectomy-scissors, Wecker's scissors may also be used. After the excision, the iris is carefully replaced with the spatula (Fig. 66). The same thing must be done when the iris has been seized with a hook in making a coloboma.

A single bandage must be worn for from five to six days, and the patient remains in bed twenty-four hours. He should be kept under supervision for from eight to ten days, when recovery will have taken place. As a rule, there is no complicating inflammation.

Forming the transition from optical iridectomy to iridectomy performed for the relief of tension there is the operation performed for the purpose of preventing secondary glaucoma. When the pupil is adherent around the entire periphery, or there is only a small gap left in the circular synechia, it is better not to wait until the tension has actually increased and irritation and sensitiveness have made their appearance; it is much better to take advantage of the time when the eye is at rest to make an opening in the iris for the purpose of restoring communication between the space behind the iris (the posterior chamber) and the anterior chamber, as sooner or later there is danger of bulging of the iris from an accumulation of aqueous humor behind it, producing an increase of tension.

In this form of iridectomy the upper segment of the eye is usually selected. The excised portion need not be broad. A moderately broad keratome is introduced at the scleral border. After the iris has been seized with the forceps it is slowly drawn out, because the adhesion be-



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tween the piece of iris and the lens has to be separated. In some cases, if the adhesion is very dense, the edge of the pupil remains behind on the lens, where it should then be allowed to remain.

Even in case of an extensive anterior synechia—that is, an adhesion between the iris and the cornea as a result of perforation, with ulcer or injury of the latter—it is often advisable not to wait for secondary glaucoma, which is so apt to follow this condition, but to relieve the pressure on the iris by iridectomy as soon as the eye has been quiescent for some time.

2. Iridectomy for the Relief of Increased Tension.

As the object is not to improve vision, the iridectomy should, whenever possible, be covered by the upper lid, and a broad piece of the iris extending to the periphery should be removed.

The discovery that iridectomy cures glaucoma is the immortal achievement of Albr. von Gräfe (1856). Before his discovery, all eyes affected with glaucoma, without exception, went blind after a longer or shorter space of time. The fifty years that have elapsed since then have shown that iridectomy, when performed in time, is the best method of treating glaucoma, but that in advanced and chronic cases the cure effected by this means is not certain nor always permanent; for relapses occur even when the operation has been correctly performed. In hemorrhagic glaucoma, iridectomy usually fails to have the desired effect and may indeed do more harm than good. As in old cases of ordinary glaucoma iridectomy may make matters worse, the chief indications for iridectomy in cases belonging to the group of primary glaucoma are acute and subacute glaucoma, and simple glaucoma when not too far advanced—that is, when there is not much narrowing of the visual field from the nasal side. In childhood, if the child is not very young and the glaucoma not very far advanced, iridectomy may be tried;

but in all other cases of infantile glaucoma sclerotomy is to be preferred. The latter operation is more advisable also in advanced cases of simple glaucoma and hemorrhagic glaucoma, although it sometimes has to be repeated several times.

In secondary glaucoma, iridectomy is indicated when there is a circular synechia. In the remaining varieties of secondary glaucoma, sclerotomy or puncture of the cornea usually suffice.

The eye should be prepared for a glaucoma iridectomy by the instillation of miotics (physostigmin and pilocarpin), and this preparatory treatment is the more necessary the shallower the anterior chamber, because it enables the operator to carry out the operation correctly. The deeper the anterior chamber and the narrower the pupil—two conditions that are brought about or favored by the use of miotics—the easier it is to introduce the keratome correctly, and the more effective will be the excision of the iris. Other preparatory measures include rest in bed and judicious use of morphin to induce as much sleep as possible; for sleep has a favorable effect on the intra-ocular tension. It is not wise, however, to spend more than twelve to twenty-four hours in preparing a patient for operation in cases of acute glaucoma. If by that time the anterior chamber has not become deep enough, either a preparatory sclerotomy should be performed or an iridectomy should be effected with a narrow knife or by incising from without.

Preliminary local anesthesia with cocain and adrenalin is most important. [In acute glaucoma, when not contraindicated by physical conditions, general anesthesia is preferable.—Ed.] What was said above on p. 31 applies to these cases. It is also necessary to instil physostigmin (eserin) into the other eye for some time before operating, in order to guard it against an attack of glaucoma from the excitement of the operation. [Eserin should be used on the unoperated eye during the convalescence from the iridectomy. Both eyes should be band-

Plate 6.

Iridectomy in glaucoma.

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aged until the iridectomy wound has healed and the anterior chamber is restored.—Ed.]

It is more important in this instance than in any other to see that the patient is in a proper position. If the operation is painful, an unduly soft and yielding pillow will permit the patient to draw the head back, and thus greatly endanger the success of the procedure. The head should therefore be placed on some hard substance and held very firmly, so as to keep it absolutely immovable during the painful process of drawing out and cutting off the iris.

The light for this form of iridectomy must be at least as good as for a cataract operation.

(*a*) In the great majority of cases the *keratome* is to be preferred for iridectomy, because the wound which it makes, as a rule, heals more quickly and more kindly than a wound made with a narrow knife. It is true that the latter is easier to handle and, perhaps, would be better for a beginner to use instead of the keratome, which is often very difficult to manage when the anterior chamber is narrow, and always places the lens in some danger.

After the conjunctival sac has been lightly flushed out, or, if the irritation is severe, without that preliminary precaution, the stop-speculum is inserted, the globe firmly held below with the fixation-forceps, and the keratome introduced from above into the anterior chamber, either as shown in Plate 6—that is, the operator stands at the patient's head and pushes the keratome away from his body—or he stands by the side of the patient and, after introducing the keratome, pushes it toward his body. The keratome is introduced 2 mm. from the transparent edge of the cornea and advanced in such a way as to make the incision parallel with the corneal border. In old persons with deep-set eyes it is often necessary, in order to get at the eye, to draw the flaccid skin of the

upper lid upward with the fourth finger (see Plate 6). The keratome should be introduced as far as possible, without, however, injuring Descemet's membrane with the point. It is also necessary in introducing it to avoid pricking the iris or even the lens. In the same way, when the instrument is withdrawn, the operator must be careful not to scratch the lens with the point. It is therefore better to depress the handle toward the patient's brow, and to bring out the point along the posterior surface of the cornea, but without touching the membrane.

If the anterior chamber is shallow and it is impossible to advance the keratome far enough, the incision may be enlarged to one side as the instrument is withdrawn by turning the point in that direction and cutting as it is withdrawn. It is always well to press the keratome against the iris, in order to prevent prolapse of the latter from the wound.

The excision of the iris, which now follows, requires a good assistant and perfect fixation of the patient's head, if the eye is sensitive. If the iris remains in the anterior chamber, as is best for a regular iridectomy, the curved iris-forceps (Fig. 65) is introduced (closed) nearly as far as the pupillary border; it is then opened about 3 to 4 mm., and the iris is seized. The assistant, to whom the operator has given the fixation-forceps after completing the incision, now has the important task of holding the globe rigidly and preventing it from rotating upward, because as soon as the sensitive iris has been seized with the forceps and drawn out the patient reflexly rotates the eyeball upward in proportion to the severity of the pain. This upward rotation makes it difficult or even impossible to draw the iris forward properly and cut it off as it should be done. But the assistant must not depend solely on the conjunctiva, in the grasp of the forceps, to draw the globe downward, because, as this operation is frequently performed on old persons with friable conjunctivæ, the membrane would simply tear, and fixation would be at an end. He must, on the contrary, utilize the sharp corners

of the forceps for fixation by pressing them into the sclera, and thus strengthening his hold on the globe. For that purpose the forceps must, of course, be brought into a more vertical position in relation to the globe than as shown in Plate 6; and if the globe shows a tendency to escape upward, it must be pushed, rather than drawn, downward.

After the operator has drawn the iris out about 5 to 6 mm. from the anterior chamber he holds the curved iridectomy-scissors with the convex surface against the globe, seizes the extracted iris between its blades, and cuts off the membrane with one snip of the scissors, making slight traction on the iris at the same time; or he first cuts off half of the drawn-out iris and then the other, again making vigorous traction on the membrane. For it is necessary to excise a broad piece of the iris, extending as far as the peripheral insertion of the membrane, so as not to leave any more of the iris at the angle of the chamber than is absolutely unavoidable. For that reason it is indispensable to hold the scissors firmly against the globe while cutting. Wecker's forceps-scissors (Fig. 53) are also an excellent instrument for cutting off the iris. If the iris prolapses in front of the wound as the keratome is withdrawn, it should be seized transversely and cut off as described.

In this operation also it is necessary to replace the iris with the spatula (Fig. 66) after the excision has been completed (see Plate 3). Indeed, to leave the iris in the angles of the wound would be particularly dangerous in glaucoma, because it would be followed by an increase in the tension. The corners of the sphincter must be replaced in such a way as to correspond with the normal border of the pupil, so that the latter, with the coloboma, resembles an inverted keyhole. It is well to have the coloboma somewhat wider above—that is, at the periphery of the iris—than at the edge of the pupil (Fig. 8). Quite frequently in iridectomies for glaucoma the iris, which has been paralyzed by the increased tension, is slow to

return to its normal position. This may be expected when the pupil refuses to contract in spite of appropriate preparatory treatment, and the iridectomy has to be performed with a dilated pupil.

Often the dilatation of the pupil in glaucoma is greatest at its upper portion, and only a narrow hem of iris remains for excision. This disturbing factor and a deep position of the eyeball, with a tendency to rotate upward, which is often present in glaucomatous patients, who are usually advanced in years, sometimes render it advisable to place the iridectomy along the temporal or lower portion of the curtain instead of above, particularly in cases of advanced glaucoma, in which the operation is performed more for the purpose of relieving pain and saving the globe than to improve vision. In every iridectomy, and particularly when it is performed for glaucoma, it is important to avoid the error of introducing the keratome at too great an angle through the cornea (Fig. 72*a*, --------), as that would bring the inner wound too far away from the outer wound, and therefore too near the center. The wound should be as near as possible to the angle of the chamber (———), because that is the only way that adequate incision of the iris is possible. It is obvious from Fig. 72*a* that the correct incision would come into collision with the iris. Hence, after the keratome has been advanced in the direction of this line as far as the iris will permit, the handle must be gradually depressed in order that the point may miss the iris and anterior pole of the lens. The figure also shows that the sclera overlaps the cornea somewhat at the corneal border. Hence an incision

FIG. 72*a*.—Correct (———) and incorrect (------) incision for iridectomy.

2 to 3 mm. from the corneal border will encroach upon the cornea with its inner edge (which lies in Descemet's membrane) or, in other words, if the inner edge of the wound is to be placed within the corneal border—or angle of the

chamber—the outer wound must lie within the sclera, 2 to 3 mm. from the edge of the cornea.

(*b*) When iridectomy is performed with *Gräfe's cataract knife*, there is less danger of pricking the lens, and the mistake just referred to is, therefore, more readily avoided; but an incision made with this instrument, as a rule, does not close so easily, and the operator is apt to fall into the error of coming out too near the periphery, and having a prolapse of the lens, either during or after the operation, as the lens may be forced out by the intra-ocular tension if the latter does not rapidly diminish after the operation. Occasionally it takes several days for this to occur. Hence, although the length of the wound, which should be from 6 to 7 mm., has a most favorable effect in curing the glaucoma, too large a wound must, for the reasons given, be avoided.

The Gräfe knife, which should be very narrow, is carried through the anterior chamber, as in an operation for cataract, except that the point of entrance and point of exit should not be more than 6 to 8 mm. apart. The incision, which should be at the scleral border, should be about 2 mm. from the edge of the cornea at every point along its entire length. With this instrument also it is often difficult, on account of insufficient depth of the anterior chamber, to get through between the cornea and the iris, and succeed in making a sufficiently long incision.

Excision of the iris and replacement are performed in the same way as before described.

(*c*) Iridectomy by incision with *scalpel* or *scarifier* (Gayet, Schöler). Whereas, when the incision is made with the Gräfe knife, as just described, the anterior chamber is opened from within outward, it may also be opened from without inward, either with the same knife or, still better, with a broader-bellied knife, as, for example, the scarifier mentioned, or a very sharp scalpel. This method is advisable when there is little or no room between the cornea and the iris because the curtain has

been pushed too far forward, either owing to severe primary glaucoma or, very frequently, from secondary glaucoma, with bulging of the iris, as a result of a circular, or a large anterior, synechia (for example, after a large central perforating ulcer). In such a case the incision is made cautiously from without inward along the corneal or, better, the scleral, border. The incision by which the anterior chamber is opened is first made short and then enlarged with suitable scissors, [de Wecker's (Fig. 53), Stevens' (Fig. 92), or Desmarres' (Fig. 36),] the instrument being brought into play at the angle of the chamber between the cornea and the iris.

So far we have succeeded no better in explaining the effect of iridectomy in primary glaucoma than we have in explaining this form of glaucoma itself. The thought naturally suggests itself that incision of the capsule of the globe is followed by increased seepage of aqueous humor from the anterior chamber—in other words, a so-called filtration-scar is produced and furnishes a kind of safety-valve, protecting the eye from excessive pressure. On these grounds de Wecker recommended simple incision at the corneoscleral border without iridectomy, under the name of sclerotomy, and used it in the treatment of glaucoma. It was found, however, that the effect of this procedure was not as great as that of iridectomy, and that excision of a piece of iris reduced the excessive tension better than more incision, at least during the initial stage of the process. It can not be denied that sclerotomy acts well in the later stage of glaucoma and in children, and that it is possible, therefore, that part of the effect of an iridectomy is to be attributed to the increased seepage (filtration).

Since it appears, from the investigations of Knies and Ad. Weber, that obliteration of the angle of the anterior chamber (Fontana's space) plays an important part in the causation of glaucoma, and has even been considered the primary cause of the disease, the good effect of excising a piece of the iris has been explained by the open-

ing up of the angle of the anterior chamber so far as it falls within the influence of the iridectomy. As a matter of fact, however, the angle is opened up only when the iris is extirpated as far as its root, which, as appears from the anatomical investigations of Treacher Collins, is not the case as a rule. In 23 eyes which had been iridectomized for glaucoma he found that in only 2 the operative scar extended near enough to the periphery for the incision to have involved the ligamentum pectinatum. In 3 cases, in which the incision had been carried very near the periphery, the increase in tension had returned. Nevertheless, it may be assumed that the removal of a piece of iris renders the angle of the chamber more accessible, and thus improves the drainage.

Priestley Smith's theory that the way is prepared for glaucoma chiefly by the physiologic increase in the size of the lens—which occurs in advanced age—furnishes another possible explanation of the favorable effect of iridectomy and sclerotomy. As the lens increases, the space between it and the ciliary body diminishes, and if the ciliary processes become engorged with blood, the edge of the lens and the ciliary process may force the root of the iris forward, thus narrowing or even occluding the angle of the anterior chamber. This mechanism would render the effect of iridectomy intelligible, because the iris, at all events, could not be pushed forward at the site of the iridectomy; and there is another factor—for Snellen observed that every successful operation is followed by quite a considerable flattening of the cornea in the direction toward the operative wound. This flattening is necessarily accompanied by a certain dilatation of the bulbar wall in the ciliary region, and in that way there is produced a dilatation of the perilenticular space, which, according to Priestley Smith's theory, must have a favorable effect on the circulatory conditions in that region.

The after-treatment of a glaucoma iridectomy requires, first of all, a few days' rest in bed, which has a favorable effect on intra-ocular tension. The use of miotics is in-

dicated very soon after the operation, sometimes even on the first day. Pilocarpin, 2 to 3 per cent. solution, five to six times a day, if necessary, is to be preferred for post-operative use, as it is less irritating than physostigmin (eserin). Iridectomy wounds also must be kept clean, to guard against iritis. Even sympathetic disease of the other eye has been known to occur after an iridectomy for glaucoma.

The most important complication during convalescence is failure of the wound to close, because the tension fails to diminish after the operation. In such unfavorable cases, posterior sclerotomy has been recommended, combined, if necessary, with Weber's procedure (see Sclerotomy).

Total escape of the lens, which sometimes does not take place until after the operation, and occurs when the incision is too near the periphery, or too large, is undesirable, but is better than mere prolapse of the lens into the wound, which causes renewed increase of tension. Hence, the accident may have a favorable effect.

Retinal hemorrhages occurring after the operation possess little significance and are probably caused, as a rule, by the introduction of the intra-ocular tension which follows incision of the globe, and brings about rapid change of pressure in the retinal vessels. Such a hemorrhage is not a sign that the glaucoma belongs to the hemorrhagic form. But if the hemorrhage takes place before the operation, it is a sign of hemorrhagic glaucoma.

In addition to the two above-mentioned principal indications for iridectomy, and iridectomy as a preliminary operation for cataract extraction, which has been referred to, certain less frequent indications should be mentioned.

3. Iridectomy in chronic iritis to prevent relapses and clear up the vitreous. This operation has lost much of its former popularity, at least among those who only perform necessary operations. At any rate it must be performed only during an interval of entire freedom from inflammation, and even then the gap in the iris closes up

again, usually after a large hemorrhage, which more or less completely fills the anterior chamber. In the same way the relief obtained by iridectomy in cases of obstinate and troublesome flocculi in the vitreous is often but slight.

It is an absolute mistake to operate on account of a few synechiæ. The view which was held several decades ago, that synechiæ produce a fresh iritis, has lost weight since we know that iritis is usually due to a constitutional cause.

4. In cases of ectatic scars of the cornea and staphyloma-formation, iridectomy is perfectly justifiable and, as a rule, reduces the bulging in both of these conditions.

5. Iridectomy may be tried for the purpose of removing very small sarcomatous nodules on the iris. According to my experience the best procedure in such cases is, first, to make a large incision at the corneal border, equivalent to $\frac{1}{3}$ or $\frac{1}{2}$ of the circumference of the membrane, if necessary, with the scissors, and then to perform an iridectomy to the right and left of the nodule. In that way the piece of iris containing the tumor may be completely rolled out of the anterior chamber and removed, to the very root of the iris.

In the case of tuberculous proliferations it is better not to extirpate, but to treat them either by introducing iodoform into the anterior chamber or by tuberculin injections or enucleation.

III. SCLEROTOMY.

As has been mentioned, *anterior sclerotomy*—that is, sclerotomy performed at the corneal margin, represents one-half, and under certain circumstances the better one-half, of iridectomy; for it is always a less dangerous procedure, although not quite so effective as iridectomy; but it can be repeated as often as may be desirable. In infantile glaucoma, in advanced cases of glaucoma, and in hemorrhagic glaucoma I believe, from my experience,[1] that it

[1] Up to June, 1900, I had performed 570 operations on 303 adults suffering from glaucoma—279 iridectomies and 291 sclerotomies; up to November, 1899, I had performed 104 sclerotomies on 84 children affected with glaucoma.

is preferable to iridectomy, and in the remaining forms of glaucoma it is often a useful accessory or complementary operation; for in many of the cases of glaucoma that present themselves late for treatment iridectomy fails to effect a permanent cure, and sooner or later a secondary operation becomes necessary.

In the presence of iridocyclitis with deposits, causing increased tension, sclerotomy is the proper operation and iridectomy would be altogether out of place. In keratoconus, repeated sclerotomy is indicated—to arrest the progress of the disease.

Sclerotomy may be performed either with the keratome (Quaglino, Snellen) or with the cataract-knife. The latter method, proposed by Wecker, makes it possible to avoid a prolapse of the iris, which is always apt to occur when the keratome is used. The Gräfe knife is introduced much in the same way as in the operation for cataract (see Plate 7), except that the points of entrance and exit lie farther out on the sclera; the knife is drawn to and fro with a sawing movement, as though for the purpose of making a curved incision in the corresponding direction (below in Plate 7); but after the entrance and exit wounds have been enlarged to about 3 mm., a broad bridge of sclera is allowed to stand, the point of the knife as it is withdrawn being carried over the inner surface of the sclera in the angle of the anterior chamber. But in thus incising the inner angle of the chamber, as recommended by de Vincentiis and Taylor, and extending the incision from the angle of the chamber into the sclera at the level of the iris, the knife must not be inserted too deeply, as, otherwise, the iris afterward gradually slips into the incision and causes a corresponding distortion of the pupil.

In order to make this incision correctly, it is necessary to apply the fixation-forceps midway between the wounds of entrance and exit (see Plate 7). This is an important point, as it enables the operator to make this incision with such certainty and precision that little or no aqueous humor escapes, and, if necessary, it also enables him to

FIG. 73.—Small knife, after Lang, for incising the cornea preparatory to the introduction of the blunt knife, shown in Fig. 74, for the purpose of separating anterior synechiæ.

FIG. 75.—Steel spatula, after Lang, to be used in connection with a large magnet for drawing small particles of iron from behind the iris.

FIG. 76.—Curved broad needle (keratome) for incising the cornea (the needle is angular rather than curved).

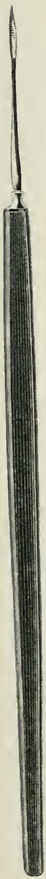
FIGS. 77 and 78.—Broad needles for incising the cornea for a narrow iridectomy, etc.

make a secondary sclerotomy immediately after the first, which enhances the effect.

Preparatory treatment with miotics is also necessary for sclerotomy, to guard against prolapse of the iris into the wound.

Under the name of *posterior sclerotomy* an operation for glaucoma has been recommended. It consists in making a short incision of the sclera with a Gräfe knife farther backward, in the equatorial region of the globe, and at the same time incising the vitreous to a considerable depth. This procedure is said to facilitate a subsequent iridectomy or to enhance the effect of the operation when it is insufficient. The patient is told to look toward the nasal side, the conjunctiva is seized with the fixation-forceps near the horizontal meridian and drawn slightly downward. With a Gräfe knife, the back of which is directed toward the cornea, the sclera is then punctured in the horizontal meridian at least 5 mm. behind the corneal margin, and the knife is advanced about 10 mm. in the direction toward the center of the globe. As it is withdrawn it is slightly turned on its axis, so as to make the wound gape and permit some of the fluid to escape. Infection is guarded against by displacing or drawing the conjunctiva to one side as the knife is introduced and by observing cleanliness. Priestley Smith only saw hemorrhage twice after this method of sclerotomy in 60 operations.

If, in from ten to twenty days after an iridectomy, the anterior chamber is not restored and malignant glaucoma manifests itself, Ad. Weber's procedure may be tried as



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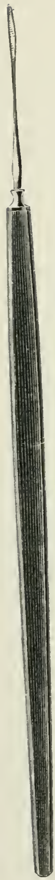

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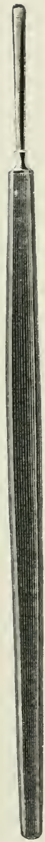

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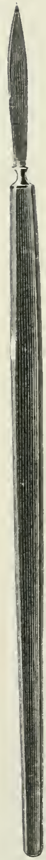

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Plate 7.

Inferior sclerotomy in a case in which iridectomy had previously been performed on account of glaucoma.

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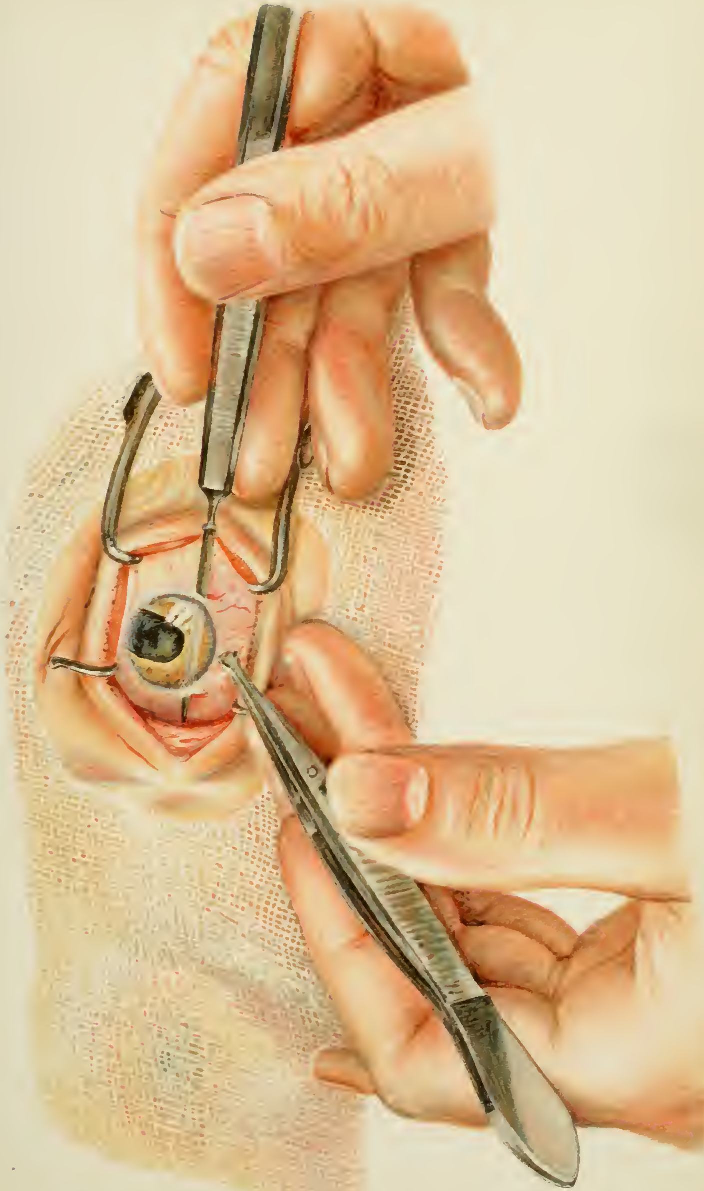
a last resort. This operation is performed as follows: During a posterior sclerotomy, such as has just been described, with an incision of 8–10 mm. out from the corneal margin, and while the wound is being made to gape by rotating the knife through $\frac{1}{4}$ of the circumference, the operator exerts pressure on the cornea for about two minutes by means of the upper lid. The pressure exerted must be slight at first and increased gradually, and must act in a direction perpendicular to the surface of the coloboma, as that is the direction toward which the dislocation of the lens is usually greatest. The object of this procedure is to force the lens back when it has prolapsed in front of the ciliary processes. When the greatest degree of pressure has been obtained it should be kept up for from one to one and one-half minutes in order to give time for the accumulation of aqueous humor.

(As regards *resection of the sympathetic*, which has been recommended for the cure of glaucoma, it is not quite clear as yet whether the operation has any great value or is even permanent in its effect, and whether the benefit derived is in proportion to the severity of the operative intervention; for we do not even know accurately whether it may not do harm in some other direction.)

An operation very much like the above-described posterior sclerotomy is *puncture of the sclera* as recommended by Deutschmann for the cure of retinal detachment. A double puncture is made and the knife is carried around the periphery instead of being introduced in a vertical direction. The procedure is most adapted to cases of some standing, in which the detachment has already gravitated downward. After the instillation of atropin, the patient is directed to look up and a bayonet-shaped two-edged knife is introduced in the lower fornix, as near as possible to the equator, and carried transversely across the lowest portion of the globe, so that the knife traverses the subretinal space, the retina, and the preretinal space, and



perforates the sclera at the inner and lower side of the globe, but does not perforate the conjunctiva. The knife is then slightly rotated and withdrawn, so as to permit subretinal and preretinal fluid to escape. Puncture from below upward is not to be recommended. If necessary, the procedure may be repeated several times at short intervals or, in some cases, after an interval of several months. If the condition still does not improve, the injection of vitreous from a rabbit should be tried. The vitreous is taken from a rabbit about three months old, and thoroughly stirred up, either pure or with the addition of saline solution. The subretinal fluid having been drained off by means of the above-described incision, the vitreous material is injected into the preretinal space—*i. e.*, between retina and vitreous. As the rabbit vitreous is stirred, gray flocculi form, which gradually sink to the bottom. The more of these flocculi that are injected, with strict antiseptic precautions, of course, the more severe will be the inflammatory action. This procedure is only adapted in cases in which all other hope of preserving the eyesight has been lost.

L. Müller recently recommended an operative procedure for the cure of retinal detachment. It consists in the *excision of a myrtle-shaped piece of the sclera* in the equatorial portion of the temporal half of the globe. He claims that this reduces the volume of the globe and at the same time corrects the tension of the choroid and retina in the long, myopic globe. The effect of this operation is said to be that the retina, choroid and sclera are enabled to adapt themselves to the altered volume of the vitreous. The outer orbital wall having been temporarily resected, after Krönlein, the temporal half of the globe is exposed, and the external rectus divided after it has been secured with two ligatures. With a small, but broad and very sharp, scalpel a short incision is then made in the most superficial $\frac{2}{3}$ of the sclera, at a point about 1–2 mm. behind the external rectus, and then a second one, parallel to the first and to the same depth, at a point 8–10 mm. farther back, both incisions being parallel to the equator. The operator must be careful to keep in front of the vortical veins. These incisions are then prolonged upward and downward and allowed to run together above and below. Sutures are then introduced at intervals of 3 mm. from the anterior edge of the anterior incision to the posterior edge of the posterior incision, and temporarily pushed out of the way with their ends lying up and down. The scleral incisions are then deepened

FIG. 79.—Small sharp scoop.
FIG. 80.—Small, sharp fenestrated scoop.
FIG. 81.—Small sharp scoop.
FIG. 82.—Paracentesis-needle with stylet, after Desmarres.
FIG. 83.—Cautery.

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until suprachoroidal serum escapes, after which the entire piece of sclera thus marked is dissected out with small straight scissors, by connecting the incisions above and below. The choroid must not be injured. The excised piece of sclera should have a width of 8–10 mm. and a length (in the line of the equator) of 20 mm. The choroid, which is thus exposed, is now punctured near the lower angle of the wound, to allow the subretinal serum to escape. The five sutures are then tied and the choroid contracts and slips under the sclera. The external rectus, as well as the incision in the orbital periosteum, are united, the bone replaced, and the outer wound closed.

It is as yet too early to determine what the permanent results of this procedure will prove to be.

IV. OPERATIONS ON THE CORNEA, SCLERA, AND CONJUNCTIVA.

1. Among the operations to preserve the integrity of the cornea the most important, because the most frequent, is the **removal of foreign bodies,** consisting of iron, stone, etc., that have entered the tissues of the membrane. Even when the foreign body is quite superficial, its removal requires some knowledge of technic as well as of the after-treatment; for it is not enough to remove the minute foreign body, it is also necessary to prevent the slightest inflammation from developing at the site of the injury. Secondary infection of corneal wounds of this kind may be followed by obstinate inflammatory processes and the development of permanent opacities in portions of the cornea; whereas, with proper treatment such opacities can be avoided.

When the foreign body is quite superficial an attempt should first be made to rub it off with a sharp probe, armed with cotton and moistened with a bichlorid solution of 1 : 5000. If this attempt fails, and, generally, when the foreign body is more deeply situated, it must be dug out with a spud. This is usually quite difficult, espe-

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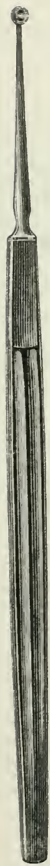

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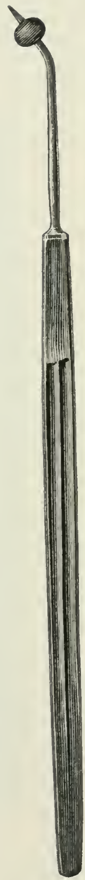

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cially if the particle of iron was hot when it entered the eye, as it is then usually surrounded by a brownish eschar, which must also be removed. Small particles of stone, especially such as are acquired by working with granite, also, as a rule, present considerable difficulties,

Fig. 84.

particularly if the illumination is insufficient and the patient is not fairly quiet. The whole procedure is, of course, greatly facilitated by thorough cocainization and, if there is great irritation, by the addition of adrenalin as well; and above all, by the use of an apparatus

designed by Sidler-Huguenin (Fig. 84). With this apparatus the light from a lamp, which is placed to one side, can be concentrated on the operative field by means of an illuminating lens (the larger of the two lenses in the figure), which is attached to the patient's forehead; while at the same time the field can be studied with a magnifying glass, so that the foreign body can be removed with great accuracy.

This apparatus will be found to give excellent results when one is obliged to operate on foreign bodies without an assistant.[1]

Sharp knives or discission-needles are better than the small gouge which is usually recommended for removing foreign bodies from the tough corneal tissue, because the gouge usually lacks a sufficiently sharp edge, and, therefore, crushes and injures the tissue. If a surgeon's hand is so unsteady that he is in danger of perforating the cornea with the sharp instruments referred to, he ought not, under any circumstances, to undertake operations on the eye.

The removal of a foreign body consisting of some material other than iron from the deepest layers of the cornea may be a very difficult operation, requiring great coolness and patience. While the extraction of an iron spicule is greatly facilitated by the use of the large magnet (the small magnet, as a rule, is of little use, because the foreign body is usually small, and the magnet does not exert sufficient attraction), a small particle of stone or copper simply requires patient digging, but there is always danger of the foreign body being pushed all the way into the anterior chamber. To avoid such an unpleasant accident in a given case it may be necessary to insert a narrow keratome or the angular broad needle (Fig. 76) into the anterior chamber and hold the point against the foreign body in order to prevent its slipping. A deeply embedded splinter of this kind is best removed with a Gräfe cataract-knife, also, of course, under good illumina-

[1] It can be obtained from Goldschmid, optician, in Zurich.

tion. The operator first cautiously cuts down on the foreign body and then works away with the point of the knife and tries to pick out the splinter. The use of the forceps should be avoided, because the attempt to seize a splinter with the forceps, as a rule, results in thrusting it farther into the tissue.

After the removal of any foreign body from the cornea, even when it is very superficial, the membrane should be examined with a magnifying lens to make sure that the tissue has been thoroughly cleansed. It is also of the greatest importance to enforce careful after-treatment in any injury by a foreign body. This is done by keeping up the occlusive bandage until the defect is found to be well covered with epithelium.

Special care is required in removing foreign bodies that have lodged in the depths of the sclera, and can not be drawn out with the magnet, because they do not consist of iron. They must be carefully pried out after the conjunctiva has been incised and drawn apart to obtain a cleaner operative field.

If for any reason it becomes necessary to open the globe with a scleral incision, the rule is to place the incision in a meridian, and not in the equator, so as to minimize gaping and injury to the choroidal vessels, most of which are in the anterior half and run parallel to the meridian.

2. The operation of **puncturing the cornea** for the purpose of removing the cataractous masses, which has already been referred to, is more or less extensively used for other purposes. To afford escape for fluid, such as blood, pus or mere aqueous humor, from the anterior chamber, a small puncture, known as paracentesis, suffices. For this purpose Desmarres' instrument with a stop (Fig. 82) is used, because with this instrument the puncture, which is usually placed between the periphery and the center of the cornea, can be made to gape by means of the stylet, with which the peripheral edge of the wound is pushed back.

Blood in the anterior chamber may, as a rule, be

allowed to become absorbed. There are cases, however, in which, for diagnostic purposes, for example, to determine the presence of a foreign body, the removal of the blood becomes desirable. There are also cases of glioma of the retina in which the hemorrhage takes place in the anterior chamber and obstructs the view of the interior of the eye. In a case of this kind I once succeeded, by performing this trifling operation, in determining the presence of the dangerous tumor at once.

Paracentesis of the cornea is also performed in cases of *deep corneal ulcers* that threaten to rupture. In this way an extensive ulceration with breaking down of tissue can be guarded against. In ulcus serpens, especially, a large incision or splitting of the cornea is often resorted to. Saemisch's operation consists in dividing the entire ulcer. The eye having been well cocainized, the patient's head is held between the hands of an assistant, and the globe steadied, while a Gräfe cataract-knife, with the edge presenting forward, is introduced into the anterior chamber behind the ulcer, entering, as well as emerging on the opposite side, beyond the edge of the ulcer, in sound tissue. The incision is then slowly completed by drawing the knife forward. The last instant of the incision is usually very painful, because, after the contents of the chamber have escaped, the inflamed iris comes in contact with the cornea. The direction of the incision should be such that the most purulent advancing edge of the ulcer is divided in two. The incision should be opened up every day with a blunt probe, or a Weber knife for opening the nasal duct (Fig. 145), until the ulcer clears up. Both at the first incision and at the subsequent reopening of the wound, injury of the lens must be carefully guarded against.

According to Alf. Gräfe and Meyhöfer, an incision that does not divide the ulcer, but runs at a tangent to the advancing edge of the ulcer, as a kind of demarcation line in the sound tissue, also has a favorable effect on the ulcer.

The incision in purulent corneal ulcers evidently acts

in the same way as the incisions made by surgeons in cases of phlegmon, they relieve the tension of the tissue and assist in its cleansing by providing automatic drainage; for a current is set up in the tissue toward the incision, and not only resists the advance of the microbes, but improves the nutrition. If there is any objection to treating these purulent ulcers of the cornea, from the beginning, with an incision, because it sometimes causes anterior synechiæ and its unpleasant consequences, the purulent portions may be scraped out with a sharp scoop (Figs. 79–81) and dusted with iodoform, or, still better, destroyed by heat—*i. e.*, by means of the small galvanocautery (Fig. 83) or the platinum cautery.

3. **The Operation for Pterygium.**—The removal of a pterygium may be deferred until the advancing apex of the fold begins to show thickening. If the pterygium has a flat point and is not very vascular, it may be left to itself; but when it has already advanced to the pupillary region it is best to remove it at once. Cauterization, which is often desired by patients who are afraid of the knife, is not to be recommended; a better operation would be to ligate the membrane off with silk sutures, which, however, requires a longer time for recovery than ablation or transplanting.

(a) *Ablation after Arlt.*—After the eye has been thoroughly cocainized and thoroughly cleansed, the pterygium is seized at the "neck"—that is, about the region of the corneoscleral margin, with a straight conjunctival forceps (like the instrument illustrated in Fig. 88) and lifted away from the globe. In this way it is quite easy to separate the part that lies on the cornea with a cataract-knife or keratome. The membrane must be removed absolutely clean, so as to leave no part of the "head" remaining. The membrane ought, in a sense, to be peeled off. With a straight or curved scissors the body of the pterygium is then excised for a distance of 6 to 8 mm. by means of two incisions, converging toward the caruncle. The triangular wound in the conjunctiva (base of the triangle at the cor-

neal margin) is then united by means of a suture. When the pterygium is large, a small incision, about 5 mm. long, should be made above and below, in the edge of the conjunctiva, at a tangent to the corneal border, before the wound is drawn together, as, otherwise, the suture causes too great tension. That part of the sclera near the corneal margin which corresponds to the "neck" of the pterygium must not be covered with conjunctiva.

(b) *Transplantation.*—This operation was practised by Desmarres and, according to his method, consists not in excising the pterygium, but in merely separating it from the cornea for a distance of from 5 to 6 mm. The tag is then displaced obliquely downward and sutured into the conjunctiva, being inserted through an incision made for the purpose and running from the pterygium obliquely downward. This incision at once gapes, the separation being greatest near the pterygium, and thus forms a suitable triangular wound for the reception of the tag.

For a broad pterygium, Knapp modified this method as follows: After the head of the pterygium, if it is hard, has been cut off, the fold is divided horizontally, and the two tags are sutured into the conjunctiva, one obliquely upward and the other obliquely downward, into two similar triangular wounds. The original site of the pterygium is then covered with conjunctiva by undermining the upper and lower edges of the membrane at the corneal border and introducing two sutures, which suffice to cover the defect completely.

Another useful method is McReynolds' modification of Desmarres' operation. In this operation the pterygium is also displaced obliquely downward, but at the same time it is pushed under the conjunctiva. The pterygium is dissected away from the cornea, just as in Arlt's method; but after that the structure is merely loosened from the sclera and undermined at its lower border by an incision running obliquely downward along the edge of the fold —*i. e.*, in the case of nasal pterygoma, the direction of the incision would be inward and downward. The con-

junctiva is then undermined below and outside of the incision, and a suture with two needles is passed through the head of the pterygoma. By means of the suture the tip of the pterygoma is then drawn obliquely outward and downward under the conjunctiva, the two needles are brought out on the surface of the conjunctiva, and the suture is tied. No incision is made at the upper border of the pterygium. [This is the most satisfactory pterygium operation.—Ed.]

4. The **utilization of the conjunctiva to cover defects in the cornea,** either by transplanting little flaps without pedicles or by employing a flap with a single or double pedicle—in the latter case a bridge-like flap—is a procedure that was first attempted by Schöler and later perfected by Kuhnt. The method is of use to afford temporary protection in cases of slowly healing ulcers, and in cases of wounds of the cornea and at the scleral border. It may also be used to give permanent protection to parts that have a low resisting power, as, for example, after a prolapsed iris has been removed, to cover distended scars containing iris tissue or a staphylomatous bulging. Ulcers must first be well curetted, keratoceles and beginning staphylomata must be freshened up, so that the flap will adhere, either by carefully removing the superficial layer with a trephine and keratome, or by scorching superficially with a galvanocautery and scraping away the eschar after three days.

5. **Tattooing of the cornea** with Chinese ink is an important auxiliary measure and is employed either to obviate the blinding effect of light, when diffused through a thin corneal scar or patch, or, for cosmetic reasons, to give a dark color to unsightly white spots on the cornea, or, finally, in certain cases of cataract, when there is much disfigurement on account of the whitish sheen, and an operation for its extraction is contra-indicated by retinal detachment or other extensive traumatic changes in the eye. In these cases a black spot is tattooed on the clear portion of the cornea to simulate a pupil.

So far I have not had occasion to tattoo an iris on the normal cornea of an albino to prevent the blinding effect of light, but should not hesitate to do so as soon as I had a chance.

Finally, it may be necessary to imitate the iris when, for example, the entire cornea is gray or a turbid white. In that case other colors besides black must be used. In selecting the colors only those should be taken that are not soluble and do not irritate. According to my experience such a color is cinnabar, as it is sold, for example, in the form of a water color put up in tubes, which, when mixed with Chinese ink, makes a very useful black. To obtain other colors, especially blue, Cofler used Japanese tattooing-colors, for which he sent to Tokio. As a substitute for an artificial eye, de Wecker, who introduced tattooing in 1870, advised its use on an iris and pupil in shrunken eyes possessing only a small remainder of cornea. When the pupil is small, tenotomy is first performed on the four straight muscles of the eye in order to make the pupil more prominent and more nearly circular. de Wecker claims to have had very good results with this method.

Cofler also recommends tattooing a line of color along the edges of the lids to make up for the disfiguring of eyelashes.

For black, which is the color most frequently used, the best Chinese ink, rubbed up in a glass or porcelain dish until the consistence is fairly thick, should be used. The ink should be rubbed up in a few drops of 1:1000 bichlorid solution, for in this operation also infection should be carefully guarded against, and in case of dacryostenosis or catarrh, appropriate precautions must be taken. I saw a case in which tattooing (not performed by myself) caused panophthalmia. By observing all the rules of antisepsis, I have never seen inflammation after a tattooing operation. For pricking the tissue it was formerly customary to use five or six cambric needles, tied together in a bundle, so as to make a number of punctures

at the same time; but this method is not to be recommended. Hollow needles have also been devised (Bellarminow), and an instrument that is filled by a spring (Niedem), and with which the color can be introduced at the same time that the puncture is made, thus enabling the surgeon to sketch out the design accurately. If necessary, however, a discission-needle will do. The pricks should be made somewhat obliquely. A small quantity of the ink may be first painted on the spot that is to be tattooed, and the needle thrust through it when the pricking is done, the color being afterward rubbed in with a smooth spatula; or the pricking may be done first and the color rubbed in afterward. The eye should be cocainized; but the globe must not be held with the forceps, as the point where the forceps is applied is also apt to become black. The globe may be steadied with one finger.

Tattooing must never be performed while the eye is inflamed. Ectatic scars are not suitable for this procedure.

Sometimes it is necessary to repeat the tattooing after a time, probably because part of the ink has been carried off by wandering cells, or, possibly, has disappeared by exudation.

6. **Removal of Dermoids.**—Benign but disfiguring tumors at the corneal margin not infrequently require operative removal (see *Atlas and Epitome of External Diseases of the Eye*, Plate 11). These hard tumors are known as *dermoids*, and may be treated in the same way as a pterygium. It is necessary to be very careful, however, not to make an opening in the cornea. Even when extirpation is properly performed, there remains at the site of the tumor a pale spot, which later may be colored to resemble the iris. The wound in the conjunctiva, from the extirpation of the tumor, must be covered by undermining the membrane and drawing it together. Subconjunctival lipoma, which sometimes accompanies dermoid, especially when it is very large, requires operative interference for its correction. The thickened conjunctiva is

excised and as much fat removed as is necessary to cause the disappearance of the structure from the palpebral fissure.

Carcinomatous and sarcomatous growths, which preferably begin at the limbus of the conjunctiva, can be locally extirpated only when they are quite small. They must be removed as well as possible with a knife and scissors, and the site cauterized as thoroughly as possible, with the Paquelin, or the galvano-, cautery, without destroying the integrity of the globe. If a tumor of this kind be large, enucleation of the globe is indicated; but in cases of suspicious-looking nodules a piece of tissue should be excised for examination, in order to determine whether the growth is not a benign papilloma instead of a carcinoma.

Polyps and papillomata of the conjunctiva, the latter occurring chiefly at the inner canthus, require thorough extirpation, after which the wound is covered with conjunctiva.

6. **A staphyloma of the cornea** may call for various interventions, depending on the position and size of the growth. In the case of partial staphyloma an iridectomy to relieve pressure often acts very favorably. Excision may, however, be required, the wound-edges being afterward brought together with sutures; or a conjunctival flap may be drawn over the defect. In one case of staphyloma, about 5 cm. in diameter, situated at the limbus of the cornea, and wishing to have as firm a scar as possible, I succeeded fairly well by dividing the staphyloma laterally after thoroughly curetting it. The peripheral portion was then tucked in under the central portion, which formed a flap, and the entire wound covered in with conjunctiva and closed with sutures.

In cases of large, or even total, staphyloma the condition may be improved by excising some part of the growth. Snellen recommends for this purpose a procedure which may be said to occupy an intermediate position between total amputation, as done by Beer and Crit-

chett, and Küchler's method of splitting the staphyloma, transversely delivering the lens, and in allowing the wound to heal under an occlusive bandage. He excises a comparatively small piece from the bulging mass by passing a couching needle transversely through the tip of the staphyloma, and then with a Gräfe cataract-knife makes two converging incisions from without inward, one on each side of the needle, thus excising a segment which remains transfixed by the needle. If the wound is found to be too small to allow the lens to escape after its capsule has been opened, it should be enlarged to the right and left with the point of the knife. The two wound-surfaces are readily brought into opposition by slight pressure, such as is produced by an occlusive bandage.

In amputation of the staphyloma and evacuation of the lens, after Beer, who subsequently simply allowed the large wound to heal under a bandage, de Wecker advises that the conjunctiva should first be incised all around the cornea and undermined, and a tobacco-pouch suture introduced, which is afterward drawn tight over the wound. Suturing the sclera alone, after Critchett, when some of the sutures necessarily go through the ciliary body and, certainly, through the interior of the globe, is a dangerous procedure and has caused sympathetic ophthalmia. If the sclera is to be drawn together by sutures, it must be done in the way recommended by Knapp—that is, before amputation is performed the sutures that pass through the conjunctiva and sclera must be introduced in such a way as to pass only through the most superficial layers of the sclera.

In the case of a very large staphyloma or one that extends into the region of the ciliary body or is confined to that region, enucleation [or Mules' operation.—Ed.] is the proper operation if the growth is causing any disturbance.

V. OPERATIONS IN THE ANTERIOR CHAMBER.

In addition to the operations affecting the anterior chamber, which have already been referred to—namely, iridectomy, sclerotomy, the introduction of iodoform and the extirpation of small tumors, there remain to be considered the following:

1. **Separation of Anterior Synechiæ.**—By this procedure a distorted pupil may be made to assume its proper position, and distortion of the iris, particularly—which is sooner or later followed by glaucoma—can be corrected. We also know that corneal scars containing inclusions of iris are dangerous, on account of the possibility of infection. The slightest loss of tissue in such scars, either spontaneously or from injury, may give entrance to a violent infection, often in the form of a rapid progressive panophthalmia, and cause the destruction of the eye. Attempts were formerly made to separate these adhesions between the iris and cornea by means of an iridectomy; but this is often a very difficult procedure. Even with Gräfe's knife it is often very difficult, if not impossible, to separate such an adhesion if it is broad. It is more easily done with the two needles devised by Lang (Figs. 73 and 74), one of which is used merely to make a small incision in the cornea, while the other, which is blunt at the point, is introduced into the chamber for the purpose of separating the iris from the cornea, partly by a cutting, and partly by a scraping, movement. It is important that the aqueous humor should not escape during the operation; hence, the shaft of the knife should occlude the wound in the same way as has been explained in connection with discission (see p. 115). If the aqueous humor escapes, the iris comes in contact with the cornea and puts an end to the free and correct action of the knife. It is, therefore, important that the incision, which is made with the first knife, or needle, should not be too close to the synechiæ. The best place for it is the limbus of the sclera. The operation is not altogether easy. It, there-

fore, requires thorough cocainization and a good light. A bandage is necessary for a few days only.

2. The **separation of posterior synechiæ** also was formerly considered important, because they were regarded as possible causes of secondary attacks of iritis. Blunt hooks were devised for the operation. It is an unnecessary one, however, and, if the synechiæ are robust, it is not without danger, on account of possible injury to the capsule of the lens.

3. The removal of foreign bodies from the anterior chamber will be discussed in the next section.

VI. REMOVAL OF FOREIGN BODIES FROM THE INTERIOR OF THE EYE.

For the sake of the operative technic we must distinguish between foreign bodies of iron and foreign bodies of some other material. In the case of the former the magnet can be used, while the extraction of the latter is much more difficult, and the operation is often absolutely hopeless.

Fortunately, the great majority of foreign bodies that enter the interior of the eye consist of iron. In my list of cases 66 per cent. of those in the anterior chamber, lens and iris, and 75 per cent. of those in the vitreous, retina and choroid, were of iron.

(a) Removal of Spicules of Iron from the Eye (Magnet Operation).

As it is usually very difficult to seize a foreign body in the interior of the eye with the jaws of the forceps; and when the foreign body is surrounded by the slippery vitreous the attempt is practically impossible, the employment of the magnet—at first only for the purpose of grasping such spicules—marks a great advance in ophthalmology, for which we are indebted to McKeown (1874). For his first operations he used a stationary magnet 8 in. long and pointed at each end, which he inserted into the interior

of the globe, either through a scleral incision or through the entrance wound made by the foreign body. Grüning also used a similar stationary magnet. Soon, however, the **electromagnet** came into general use—after Hirschberg (1879), Fröhlich, Bradford, Simeon Snellen, and others had designed and recommended a number of useful electromagnets. A powerful magnet can be made by taking a nucleus of soft iron, about 10 cm. long and 1 to 2 cm. thick, wrapping it with many turns of copper wire, and surrounding the whole by a moderately strong current from a large immersion battery. One end of the magnet is provided with a thread for receiving attachments of varying shape and thickness. All these small magnets were and still are constructed on this principle. In order to extract a spicule from the interior of the eye with one of these instruments, it is necessary to bring the point of the probe, which is attached to the magnet, in contact with the foreign body, especially if the latter is more or less tightly wedged or lodged in the tissues (retina, etc.), or in exudate or blood. The small magnet is the best instrument for seizing foreign bodies of this kind, much better than any pair of forceps; but at best the small magnet may exert a very slight attractive power in a non-infiltrated vitreous; that is to say, it may attract a spicule which is distant from 2 to 3 mm. from its point, but only when it is quite loose. To operate successfully with this magnet when the foreign body is lodged only moderately tight, it is necessary to know approximately the location, in order to bring the magnet into close contact with it. As, however, in many cases—at least one-half in my list—spicules enter the globe, injure the lens, and very frequently produce cataract within twelve to twenty-four hours, thereby making it impossible to see the interior of the eye, and as hemorrhage into the vitreous may also obscure the position of the splinter, the use of the small magnet very often necessitates uncertain and haphazard groping about, with the result that the splinter not infrequently remains lying or sticking in the eye. A

still greater disadvantage of this procedure is that, as a rule, in order to succeed in withdrawing a foreign body from the depths of the eye (behind the iris and the lens), a rather large scleral wound (6 to 8 mm. in length) is required, or the entrance-wound has to be greatly enlarged to permit the introduction of the magnet into the interior of the eye. The entire operation, especially when the magnet is repeatedly introduced into the eye—as often happens when the surgeon is unsuccessful—constitutes a very serious traumatism, which is therefore superadded to the injury produced by the foreign body. This traumatism may prove fatal, especially for the vitreous, which is not only more or less destroyed, but also escapes in part, or at least enters the wound, and is in danger of becoming secondarily infected. During the operation possible infection of the interior bulb can not be excluded, because, as has been pointed out, the region is one that can not be rendered absolutely sterile.

Furthermore, probing for a splinter with the magnet in a more-or-less-recent wound, as is customarily done, is a questionable procedure; for it is contrary to the fundamental principle of the treatment of wounds of the eye—which is, never to probe a wound of the globe, because in so doing there is great danger of carrying into the interior of the eye any pathogenic germs that may have already settled on the wound. It is perfectly obvious that such wounds can not be aseptic before the probing is done.

In spite of these objections the employment of the small magnet was already a great step in advance. By its help many eyes, when treated cautiously, were saved, which before the introduction of the magnet would have required enucleation to avoid blindness. Hirschberg, in particular, has devoted a good deal of work to the development and popularizing of the method.

An important improvement was added to the procedure by the employment of freely moving **magnetic needles** to point out the situation of the iron spicule in the eye. The method had not been in use long before it was

unpleasantly brought home to most operators who used the small magnet that the search for a foreign body in the interior of the bulb must necessarily be carried on in the dark and in a more or less haphazard fashion, resulting in a comparative stirring up of the contents. Thus, in 1881, Knapp wrote: "Since probing the vitreous is by no means a harmless undertaking, we must exercise all our acumen and call to our aid every means at our command to determine not only the presence, but also the exact location, of a piece of iron to the vitreous." He thus pointed out the importance of the investigations pursued by Pooley, in his laboratory, to throw light on the demonstration and localization of iron particles in the eye through the deviation of the magnetic needle. In the same year H. Pagenstecher published his experiment investigations, which likewise prove the diagnostic value of the magnetic needle. Fröhlich, in 1882, for the same purpose recommended a magnetic needle suspended by a thread. All these early experiments, however, lack that essential requisite—an apparatus sufficiently sensitive to determine the location of the foreign body. Gérard's instruments, recommended by Gallemaerts (1890), and the one designed by Asmus (1894) were the first that possessed sufficient sensitiveness; the manner in which the needle was suspended in Asmus' instrument, particularly, rendered it practically very useful. The desired degree of sensitiveness was obtained by attaching to the magnetic needle a mirror, which reflects the light of a lamp or the scale of a telescope, and thus makes it possible to recognize a deviation of the needle that would not be visible to the naked eye. Asmus' **sideroscope,** which can be obtained from H. Sitte, Taschenstrasse 8, Breslau, fulfils the requirements; but it is so sensitive that the needle is practically never at rest in the neighborhood of an electric street railway or a steam railroad. Hirschberg, accordingly, constructed a somewhat less sensitive "iron-searcher" with a similar lamp reflex, which moves up and down on a scale with the motion of the needle.

In many cases, however, the deviation of the needle can be recognized with the naked eye, without the aid of a telescope (Asmus).

To avoid any error in using the sideroscope, the patient should be stripped to the waist, and even then iron particles under the scalp, which are not infrequently found in iron workers, may become a source of error. The eye is then brought near that end of the magnetic needle which is enclosed in a glass tube, so as to protect it fully against any current of air. In order to make sure that the foreign body will cause a deviation of the needle, it is magnetized by applying a strong magnet to the eye, although in most cases it is already magnetized. The excursion of the needle will be proportional to the size of the splinter, and inversely proportional to the distance. Different portions of the eye are brought near the needle in succession, and the point where the deviation is greatest corresponds to the position of the foreign body. With Asmus' instrument an iron particle weighing 1 mg. can be detected in the eye.

That very desirable quality of attraction, however, namely, that of acting at a distance, is very imperfectly possessed by the small magnet. Magnetic attraction, by virtue of which, according to the old legend, the magnetic mountain drew all the nails out of ships, requires for its development a very large and correspondingly powerful magnet. Although some of the earliest ones, like those of Meyer and Minden (1842), Dixon (1858), Rothmund (1873), Hill Griffith (1882), and especially Knies (1881), who used a very strong instrument, were capable of attracting foreign bodies at some distance, the ones named above were not utilized to any extent for that purpose, and the technic was not developed. This was in part due to the fact that the apparatus which they used, owing to their bulk, were not suitable for operations on the eye. In 1892 I used a powerful Ruhmkorff magnet to attract into the anterior chamber an iron spicule which had been lodged for three weeks in the posterior capsule

of the lens, and a short time afterward two other splinters in the vitreous. I then followed the matter up and, after studying the different varieties of large magnets in our physical laboratories, constructed with the help of our physicist, Prof. Kleiner, a giant magnet (Figs. 85 and 86), which we adapted as well as we could to operative purposes. This magnet possessed the following advantages: 1. It enabled the operator to obtain a good view of the operative field. 2. It possessed the necessary power to attract the smallest splinters from the deeper portions of the eye to the anterior surface. 3. It could be instantly brought into action or rendered passive by opening and closing the electric current. It was soon found, however, that it is not enough, when an eye contains a splinter, merely to bring it within the influence of the large magnet; there must also be some provision for properly directing the enormous power of which the magnet is capable. I discovered that a foreign body which has entered the vitreous does not, as I had first thought, when magnetically attracted, simply return by its way of entrance. On the contrary, it may, for example, be drawn forward from the retina on the posterior pole of the eye, through the vitreous, in any direction; and with great rapidity if weighing 20 mg. or more, and slowly if smaller. I demonstrated by experiments performed on a pig's eye that a foreign body is drawn toward the point of the magnet, and, if the point happens to be opposite the cornea, the intrusive substance rapidly slips around the lens by the shortest route, and, puncturing the zonule of Zinn, appears behind the iris and pushes the curtain forward.

If the pupil is not very much contracted the spicule may pass directly through it and appear in the anterior chamber, thus making it appear as if it had passed directly through the lens or through the iris. It is probable, however, that a foreign body never passes through the lens in its exit from the eye, even if the lens was injured at the time of the accident; nor do I believe that

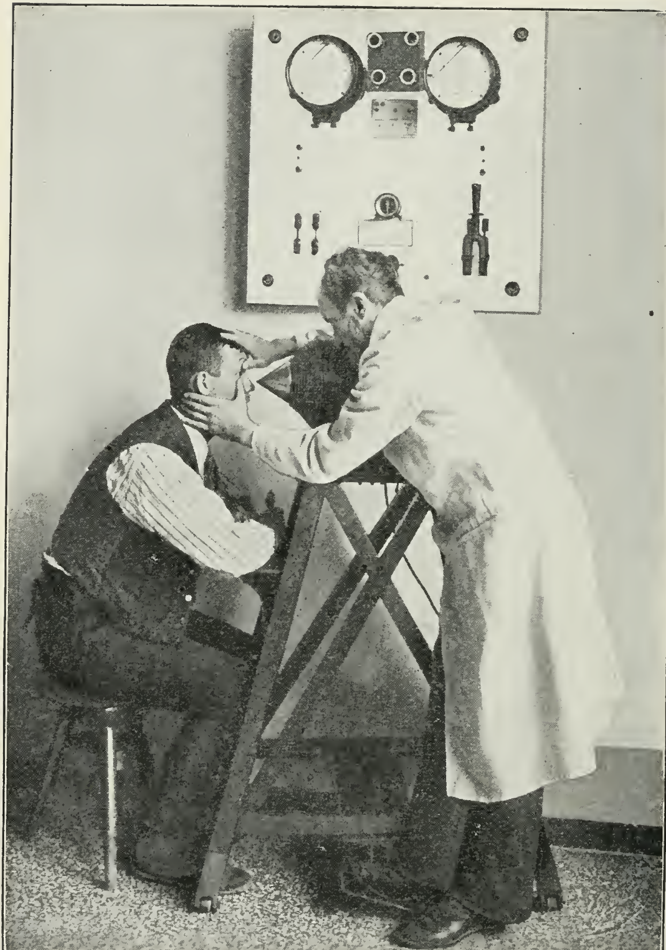

FIG. 85.—Showing the use of the large magnet in extracting an iron spicule from the eye.

FIG. 86.—Showing the use of the large magnet in extracting an iron spicule from the eye.

it is likely to make its way through the iris, except in very rare cases. It may possibly pass through the wound of entrance in the iris or, if it is a pointed object and the iris is well stretched—that is, the pupil is contracted—it may penetrate the iris near its ciliary attachment; but such accidents are exceptional. As a rule, the foreign body goes around the lens and slips behind the iris, so that, if it has lodged at some unknown point in the posterior portion of the vitreous, there is no means of knowing where it will appear behind the iris when the point of the magnet is held immediately in front of the center of the cornea. If located in the lower part of the vitreous before the magnetic attraction begins to exert its influence, it is usually drawn to a point behind the posterior portion of the iris. But if the point of the magnet, at the moment of attraction, were held opposite the upper portion of the cornea, the substance might slip around the lens and appear behind the upper portion of the iris.

In order that a foreign body that has lodged behind the iris may be drawn through the pupil into the anterior chamber, certain conditions are desirable: It should not penetrate the iris as it is withdrawn; it should be as free as possible from sharp projections and barbs; and the sphincter should be previously paralyzed in order to dilate the pupil. One of these conditions is, of course, beyond our control. To prevent the foreign body from penetrating the iris, the electric current is opened and the patient's head pushed away from the magnet at the instant the iris begins to bulge. As a rule, the patient, of his own accord, immediately jerks his head back. He is then requested to rotate the eye toward the side where the foreign particle lies behind the iris—as, for example, downward if it is behind the lower portion of the iris—so that it is drawn obliquely through the pupil into the anterior chamber.

It is also found, after a short experience with the method, that even a very powerful magnet is hardly able to withdraw a splinter that has lodged in the interior of the globe or has become surrounded with exudate, blood, etc., it

being firmly held, particularly if it has entered the posterior wall of the globe. In such cases the best results will be obtained by drawing out the spicule a little at a time, by rapidly opening and closing the current. It is also well in such cases to loosen up the spicule by bringing the point of the magnet nearer, as, for example, drawing it from the posterior pole toward the equator without, however, allowing the intruder to become firmly lodged in its new position. From the equator the spicule is then drawn toward the anterior portion of the eye. The maneuver requires a special kind of magnet; for it is necessary to be able to attract the splinter as accurately as possible toward the desired point on the equator, and it must also be feasible to open the current at once as soon as the extraneous substance has announced its presence at the equator by causing pain.

It should therefore be practicable, by means of the magnet, to lay out the track which it is to follow as it is extracted from the eye, and to prevent as much as possible, both when drawn forward and to one side (equator), its getting into the ciliary body. For I soon ascertained that it is quite difficult, when an iron spicule has lodged in the ciliary body (either primarily, at the time of its entrance into the globe, or secondarily, during the attempt to withdraw it), to extract it by means of magnetic attraction. This is probably owing to the fact that the region is full of folds and inequalities, which make it very difficult for the splinter to move.

Hence, in such cases our task will be to concentrate the action of the magnet, so that the foreign body is first drawn backward toward the equator and then forward to the anterior portion of the eye. It is better to draw it behind the iris of the opposite side, and prevent it from again slipping into the ciliary body, which lies immediately in front of it.

It was also found that in a fresh wound the splinter could at once be drawn out from the anterior chamber if it had entered through the cornea. The last step, when it

is possible at all, requires good eyesight and a strong light—in other words, the operative field must be perfectly accessible. The operator must be able to see accurately what is going on if he hopes to bring the splinter, which is freely movable in the anterior chamber and can be drawn to any desired point on the cornea with the magnet, exactly opposite the wound of entrance, so that it will pass out through the same opening. Since an oblong spicule always approaches the magnet in a longitudinal direction (head on), it is often possible to remove it in this way through the entrance-wound in the cornea if it is not too small. It is said that in a similar way a splinter in the anterior chamber can be extracted through a small incision in the cornea.

All the above-described requirements, which are fully possessed by the large or giant magnet, necessitated as great an attractive power as possible, and, therefore, a large mass of iron and a correspondingly strong electric current were necessary. At the same time we had to avoid making the implement too unwieldy in other respects. For, although the instrument is large, a certain ease in handling it is absolutely indispensable, because it must be possible to concentrate the great magnetic power on any desired or given point and allow it to act on the eye rapidly from various directions.

It would be wrong not to utilize the great mobility of the patient's head and eye; for it is hardly possible by any ingenuity, in suspending or balancing so large a mass of iron as is required for this purpose, to give it quite all the desired mobility. These considerations ultimately led me to construct the model shown in Figs. 85 and 86, which has proved its usefulness in nearly 200 operations performed with it in my clinic, and which I still consider the best, even in comparison with other large magnets that have been designed more recently.

I lay great stress on the value of having the magnet in a horizontal position and allowing the patient free movement of the head (without chin support, etc.).

Some operators have suspended the giant magnet vertically, with the patient lying on his back underneath. I consider this a faulty method because it sacrifices the free mobility of the patient's head. If the patient is seated in front of the magnet, as shown in the two figures (85, 86), his head can be moved away from the magnet much more easily than when he is lying underneath the instrument, and, as we shall see, the distance of the eye from the magnet, which may have to be changed very suddenly, plays a very important part in magnet operations.

A nucleus of soft iron, 10 cm. thick and 60 cm. long, and weighing 30 kg., is surrounded by a massive covering of copper wire, through which a constant current of 70 to 100 volts and 20 to 30 ampères is passed. The instrument can also be controlled for a tension varying from 30 to 500 volts. There is no need of a rheostat to regulate the strength of the current. The simplest way to reduce the power of the magnet is by removing the eye farther away from the pole or by lengthening the latter by using a longer attachment. The shorter the point of the pole, the greater the attraction. Although it possesses a greater attractive power, too blunt a pole is unsuitable, because it obstructs the view of the operative field too much. For the same reason the wire wrapping should diminish in thickness as it approaches the point of the pole. One pole is somewhat rounded, while the other ends in a sharp point. The magnet can be rotated around a vertical axis so that either end, the blunt as well as the sharp, can be brought opposite the eye. Both ends can be unscrewed and the power of the pole thereby increased. It is most important, in my opinion, that the magnet should be so constructed as to permit the operator to close the current with the foot, as shown in the figures (85 and 86), and leave both hands free to manage the patient's head and eyelids. As the current is closed only by depressing the pedal on one side or the other, it is passed through the mechanism only as long as it is necessary and there is no danger of the wrapping becoming heated and the instrument being ruined by the current being inadvertently kept up too long.

Another absolute necessity is good illumination of the operative field, either with the electric lamp or with the light from a large gas flame, concentrated by means of a large convex lens.

Whether the giant magnets recently constructed by Volkmann and Edelmann-Schlösser after a different type will prove practically useful remains to be seen. [Hirschberg has recently constructed a new giant magnet.—Ed.] In both of these devices it seems to me that, as the pole projects only a very short distance beyond the end surface, a maximum of power has been gained at the expense of a good view of the operative field.

The *indication* for the employment of the giant magnet is obtained from a preliminary accurate examination and the resulting diagnosis: a splinter in the eye. In case of doubt the diagnosis should be adhered to until every means of examination has been exhausted and it has been shown that the eyeball does not contain a splinter. The large magnet, of course, also represents one method of examination, and very often makes possible a correct diagnosis at the same time that it furnishes the best means of treatment. In any case, however, if the patient's statements contain the slightest hint of the fact, it should be ascertained by minute inspection of the eye under lateral illumination and, if necessary, with a magnifying lens whether or not a foreign body has entered the interior of the eye. As the great majority of foreign bodies enter through the cornea and the adjacent zone of the sclera, and many of them later pass through the iris or the lens, or both, an examination by lateral illumination in many cases reveals not only the point of entrance but also the subsequent course of the foreign body. The entrance wound in the cornea often consists of a short straight, or sometimes curved, gray line, and on close inspection a second line will usually be seen running parallel to it, which is the wound in Descemet's membrane. In cases of recent injury by a foreign body the demonstration of a wound in the capsule of the lens, which is

recognized by a grayish opacity with a dark cleft, often indicates that the intruding substance has penetrated as far as the vitreous. Careful examination with the ophthalmoscope may afford very useful additional information, either by enabling the examiner to see the foreign body in the vitreous or in the retina, or by revealing the place where it has struck against the eyeground (see my *Atlas of Ophthalmoscopy*, Fig. 51). For it sometimes strikes against the eyeground and then rebounds downward and forward. Air bubbles in the vitreous indicate the presence of a splinter, but are not absolutely pathognomonic, as they also occur after non-penetrating wounds of the eye.

The question whether the injury has caused a penetrating or a non-penetrating wound of the eye—the latter case, for example, a long splinter may have injured the eye without entering it—can sometimes be determined by noting the relation between the entrance wound and the depth of the wound canal. When cataract is present, however, the question can often be decided in no other way than by means of the magnetic needle, the Röntgen rays, or the immediate use of the large magnet to draw the foreign body to the surface. The foreign substance in such cases is usually a large one. In cases of non-penetrating wounds the iris is more likely to be prolapsed into the wound than is the case when there is an intrusion in the depths of the eyeball (Grüning). According to my observation there is one exception to this rule—that is, when a large splinter has penetrated the deeper portions of the eye. In such cases the iris may be thrown into the wound, but, as a rule, the prolapse involves only a small portion of the curtain.

Röntgen rays are indispensable for making an accurate diagnosis if it be found that both the magnetic needle and the giant magnet remain passive, and it therefore seems probable that a foreign body consisting of some other metal or of stone has entered the eye.

If the magnetic needle indicates iron and the magnet fails to act, it may be possible to show by means of radiog-

raphy that the substance has passed through the posterior wall of the globe and thus escaped from the eye. A good Röntgen-ray picture may also be of use to demonstrate the presence of a splinter in the region of the ciliary body. Such a picture will show a foreign body of 0.5 to 1 mm. in diameter, unless it consists of glass or wood, which throws no shadow at all, while stone makes a very light shadow.

In recent cases of intruding objects, especially when it may be suspected that the article has led to a complicating infection (soiled iron, especially splinter from a hoe), and the indication is to extract the material as rapidly as possible, it would be a bad practice to waste time by making a Röntgen-ray picture or using the sideroscope. It is better in such cases to use a magnet-test at once, instead of the other two methods; for the history and the size of the entrance wound give us information of some value in regard to the dimensions of an iron spicule in the eye. If such information is not obtained, the excursion of the magnetic needle may, it is true, afford valuable information. The question of the size is important, because, if the spicule is large, it must be drawn forward very slowly —that is, the eye must first be placed some distance away from the magnet and gradually brought nearer. Again, if the splinter is large, it may be necessary to extract it laterally through the sclera, instead of through the anterior chamber, bringing it out either through the entrance wound, if it is situated in that region, or through an incision made for the purpose. Whenever possible, however, the foreign body should be extracted through the anterior chamber, because by doing so any further injury to the vitreous—which is unavoidable when the foreign body is extracted through the side with or without operative enlargement of the entrance wound—is thereby saved. Even a fairly large splinter (3 to 6 mm.) can be drawn around the lens without injuring the structure. The majority of splinters, however, are smaller than the size just mentioned, and in half of the cases the lens is

already injured. It is only by extracting a foreign body through the anterior chamber that the possibilities of sparing the eye, which are afforded by the use of the large magnet, are utilized to their fullest extent.

To interrogate the sideroscope about the location of the splinter in the eye in every case would also lead to unnecessary waste of time, and when the large magnet is used, the sideroscope may be dispensed with, as the magnet itself finds out the location of the particle.

The *operation*, as a rule, is performed about as follows: Atropin and cocain and, if necessary, adrenalin having been instilled into the eye, the surrounding parts are thoroughly cleansed, and the conjunctival sac, which is often polluted in the case of workmen, is flushed out, and the patient made to sit in front of the magnet with his arms well braced. Watches should first be removed, as the steel parts of the mechanism are ruined by becoming magnetized. The operator assumes one of the two positions shown in the figures (85 and 86). If the patient is nervous and constantly draws his head back from the instrument, from fear, the operator should stand behind him. Either position permits the operative field to be well kept in view and the lids fixed with the fingers. As a rule, it is not necessary to fix the globe during the operation, but in any case the forceps that is used should not be of iron. If the operator wears spectacles with steel rims, he must be careful not to get too near the magnet, as it might snatch the spectacles from his nose at the crucial moment. For the same reason lamps that contain any iron must be kept at a distance of 10 to 20 cm.

The most important rule for the great majority of cases —that is, all those in which a small to a medium-sized splinter is present—is to begin by placing the eye with the center of the cornea exactly opposite the pole of the magnet.

If the presence of a large splinter in the eye is suspected, the pole of the magnet should first be allowed to act at some distance from the eye, the distance being

directly proportional to the probable size of the splinter. If the results of the preliminary examination indicate the probable presence of a small splinter, the cornea should be placed close to the blunt pole of the magnet, and the patient told to look in that direction. Often the first closure of the current, which is accompanied by a slight cry of pain and retraction of the head, brings the foreign body behind the iris. Sometimes pain is the only result, in which case the current must be repeatedly opened and closed to continue the attraction, the pole of the magnet being at first kept constantly opposite the center of the cornea. If this fails to produce any bulging of the iris, more lateral portions of the cornea are successively brought opposite the pole; but the region of the ciliary body must be scrupulously avoided. If this fails to attract the foreign body, an attempt should be made, as above described, to draw it laterally toward the equator of the globe. From time to time, however, the magnet should be brought opposite the center of the cornea.

Attempts to draw the splinter into the anterior chamber must not be given up too soon, for its removal may require a good deal of time and frequent jerks with the maximum of current permissible—as, for example, when the foreign body is surrounded by a small mass of exudate that causes it to adhere to the retina. This slow process of loosening up the foreign body can sometimes be observed with the ophthalmoscope. I have seen cases in which it was successfully extracted only after attempts to draw it forward had been repeated several days in succession.

In difficult cases of this kind the attractive power of the magnet may be increased by unscrewing the point. Whenever I found it impossible to dislodge a splinter embedded in the retina, which I could see with the ophthalmoscope, I would introduce a long needle (somewhat longer than the one shown in Fig. 41) through the side of the eye, under the guidance of the ophthalmoscope, bringing the point of the needle in contact with the splinter, and in that way loosening it up and drawing it forward.

To draw a splinter forward from behind the iris and through the pupil into the anterior chamber again often requires a good deal of patience and correct technic. A smooth splinter not infrequently at once slips to the front when the eye is turned in the right direction. If the current is opened immediately after bulging of the iris takes place, so that the splinter can not puncture the posterior surface of the structure, no difficulty is, as a rule, experienced in bringing it into the anterior chamber, especially when previous dilation of the pupil has been possible. So far, I have never been compelled to perform iridectomy in order to get the splinter out from behind the iris. In two cases I performed a mild iridodialysis by seizing the iris with the forceps and pushing it slightly toward the center, thus tearing it loose for a short distance at the ciliary border, and through this tear I then successfully extracted the spicule, which was lodged between the root of the iris and the ciliary body. In former years I once or twice succeeded in getting a splinter, which was lodged fast behind the iris, by means of a small smooth attachment to the small Fröhlich electromagnet, specially designed for the anterior chamber, which I introduced through an incision in the cornea and through the pupil and carried behind the iris. W. Lang recommends a similar procedure with a smooth steel spatula (Fig. 75), which he carries behind the iris, through a corneal incision made opposite the spot where the splinter is lodged, and then magnetizes by having the assistant bring into contact with the spatula a long, flexible piece of cable, about $\frac{3}{4}$ cm. thick and about 25 cm. long, containing soft iron wire and fastened to a magnet. After the splinter has been drawn through the pupil into the anterior chamber, in the manner described above, there remains, as the last step in the operation, its final extraction. This also requires a cool head and a steady hand. The small magnet may be used for the purpose, if desired; the patient may be laid upon the operating table, and the splinter extracted through a suitable corneal incision by introducing the magnet into

the anterior chamber. Personally, I prefer to finish the operation with the large magnet. In the last 68 operations I did not use the small magnet at all, and in the last 150 only three times. While the patient is still seated in front of the magnet, I make a vertical incision, about 5 mm. in length, at the proper point in the cornea, using a Gräfe cataract-knife, without causing escape of aqueous humor. The eye is then brought close to the sharp pole of the magnet until the splinter, if it is small, rises and floats free in the anterior chamber, with one end touching the incision. The patient's head is then manipulated so as to press the point of the magnet lightly in the corneal wound, whereupon the magnet, as a rule, at once seizes and holds the foreign body. If the splinter is somewhat larger, one end of it is gradually drawn up to the corneal wound with the point of the magnet, and the sharp pole is then inserted into the wound so as to distend it slightly. Two points should be insisted upon: The incision should not be too small, and in manipulating the head to extract the foreign body the aqueous humor must not be allowed to escape prematurely, as a splinter wedged between the iris and the cornea is very difficult to extract and may endanger the integrity of the lens.

In the not very rare cases in which the presence of the foreign body has already led to infection, and hypopyon, for example, has developed in consequence, a pencil of iodoform is to be introduced in the anterior chamber, through the corneal incision, before the operation is terminated (see Plate 1).

When a large splinter has made a correspondingly large wound at the corneal or scleral margin, or has perforated the sclera farther back, an attempt may be made to extract it by gently pressing the sharp point of the magnet into the wound and then closing the current. The old method of introducing the small magnet from the side may also be employed for the removal of large splinters, as in most cases of this kind no more than moderate vision can be hoped for. When the destruction has been exten-

sive, as is often the case when a large splinter has entered the interior of the eye, the surgeon must be satisfied to preserve a sightless orb.

When an iron splinter lodges in the lens, which is not a very frequent accident, it can be extracted with no difficulty whatever by means of the large magnet. When such a foreign body has lodged behind the lens, it can also, as a rule, be readily drawn forward into the anterior chamber. If the capsule offers any resistance, it must be opened with a discission-needle.

With regard to the risks that attend the procedure I have proposed, much has been said about them by the adherents of the small magnet, although most of them are without any practical experience whatever. The risk is, however, much less than when the old method with the small magnet is used; in fact, the large magnet is only dangerous when it is not properly handled. For example, when there is a splinter behind the iris, the operator should not attempt to extract it from the eye by making a corneal incision and then drawing the splinter through that incision and through the iris. It is so difficult for a splinter, even when it is sharp and pointed, to pass through the iris, that it is much more likely, if the above attempt is made, to bring the iris along with it and tear it out of the eye. Hence the point of the splinter at least must be free in the anterior chamber before any attempt is made to extract it directly through the cornea with the large magnet. It is a purely theoretic objection that, when a splinter is drawn forward by the magnet, it endangers the ciliary body or the lens. Even occasional dragging and distortion of the iris by the foreign body as it is drawn forward is of no significance. Purely mechanic injuries, as is well known, do but little harm to the ciliary body or to the iris; and as regards the lens, among my series of about 200 operations I had only 3 cases in which the lens was injured by the splinter as it was drawn forward. Besides, I consider a traumatic cataract less grave than the introduction of the small magnet into the vitreous.

For the rest, the results of the operation with the large magnet speak for themselves. In my first 190 cases the splinter was extracted 166 times, or in 87 per cent.; among the first 134 difficult cases, in which the splinter was drawn forward from behind the iris and the lens, it was extracted 111 times, or in 83 per cent. In 34 of these 134 cases the splinter was proved to have been lodged in or close to the retina, but in spite of that it was driven back from its lodging place and extracted from the eye in 28 cases. Of my first 165 cases, 55, or 33.3 per cent., recovered with good vision, as was actually demonstrated, and in 21 other cases the prospect for subsequent improvement of the vision by operation was good (cataract operation). If we include the latter among the former list, it would give us for the entire number (including the negative ones) 40 per cent. for the 141 cases in which the splinter was extracted, 56 per cent. with a useful eye. The results obtained in other clinics with the large magnet are equally favorable.

When should the small magnet be used? The answer to this question is: as little as possible in the region of the vitreous, and whenever the operator desires in the region of the anterior chamber. That it can be dispensed with altogether is shown by my series of operations. The indications for the use of the somewhat larger hand magnets, which, after the introduction of the larger magnet, were partly developed from small ones like that of Hirschberg, and partly designed anew by Johnson, Sweet, and Volkmann, possess a somewhat wider field. They have an essentially greater power than the ordinary small magnets, and, therefore, also somewhat more effect at a distance than the latter possess. [Fully admitting and admiring the value of Haab's giant magnet and the great service it has rendered to ophthalmic practice, it is proper to reiterate here the statement that equally good results may be obtained by accurately localizing the foreign body by means of the *x*-rays, and removing it through an incision placed according to the localization. This incision is small, heals readily, and apparently leaves no evil result. The magnet—it may be a giant magnet, or a smaller one, for example, Sweet's magnet—is placed at the lips of the wound and does not enter the vitreous chamber. The body is immediately extracted and does not make a long journey through the eye. Sweet's method of localizing, by means of which the smallest particles of steel are

detected, has again and again been shown to be perfectly accurate. If the *x*-rays can not be utilized in this respect, and often the means for employing them are not at hand, the method described by Prof. Haab yields the best results and should be resorted to with as little delay as possible.—Ed.]

(b) Removal from the Interior of the Eye of Foreign Bodies Not Consisting of Iron.

This variety of foreign bodies is most apt to be found in the anterior chamber. When the particle of copper, stone, wood or other material has lodged on the iris, it can usually be removed with a pair of iris forceps through a suitable corneal incision, after the pupil has been well contracted by means of physostigmin, and without performing an iridectomy. If the iris prolapse into the wound, it should be replaced. But if the splinter be solidly embedded in the tissue of the iris, a small piece of the curtain will have to be seized with it. For the removal of cilia and oblong or linear foreign bodies, a blunt hook may also do good service (Figs. 67 and 68). In many cases a forceps with thin transverse serrations or with spoon-shaped extremities is preferable to a conjunctival forceps. Knapp's hollow hook is sometimes quite serviceable.

When the splinter is wedged fast in the groove between the iris and cornea, usually the lower portion, I have found by experience that it is best to make a large corneal flap-incision at the corneal border, and, after raising the latter with a double hook (Fig. 72), have an assistant hold the iris in position with a spatula—as otherwise the curtain falls over the foreign body and covers it up—and carefully pick out the splinter with a suitable instrument. Forceps should be avoided altogether in such cases, because the foreign body, which may be partially embedded in the iris, is apt to be pushed all the way through the curtain and pass entirely out of reach. For the same

reason care must be exercised in making the flap not to exert any pressure on the splinter. Turning back the cornea, a procedure which has also been recommended by Knapp and Gayet, offers the readiest access to the anterior chamber without injuring the membrane.

Foreign bodies in the lens, consisting of some material other than iron, are to be treated as described on p. 110.

The presence of a splinter of this kind in the vitreous constitutes a much more serious injury than does the presence of an iron spicule; for its removal presents great difficulties and, as a rule, necessitates going in from the side through the sclera—that is to say, in most cases, an incision, through which an attempt must be made to extract the foreign body. It is not usually possible to seize the body with forceps, unless it is embedded in exudate which offers a hold for the jaws of the forceps. I once extracted a cartridge splinter through a scleral incision, four and one-half days after it had entered the eye, by obtaining a hold on the thin exudate by which it was surrounded. Recovery ensued with normal vision, but four years later a retinal detachment developed. I adopted a somewhat different plan in another case of a percussion-cap explosion, in which a smooth piece of copper had entered the vitreous, and the other eye had also been injured by the same explosion. A small incision was made in the sclera with a Gräfe knife, and, with the aid of a head mirror, with which the splinter can be readily seen, the pupil was dilated, a Desmarres' capsule forceps (Fig. 54) introduced and, after the delicate forceps had been opened and closed a number of times by means of the lever attached to the handle, I finally succeeded in seizing the elusive splinter and extracted it without any of the vitreous escaping through the small incision, which was completely stopped by the instrument during my attempts at seizing the foreign body, and without the instrument causing any considerable destruction in the vitreous. This operation convinced me how difficult it is to get hold of a foreign body in the vitreous, even when

both it and the instrument can be kept constantly in plain view. I may recommend Desmarres' forceps for suitable cases as one of the least destructive instruments.

Knapp's hollow hook can also be used for extracting splinters of this kind.

B. OPERATIONS OUTSIDE OF THE EYEBALL.

I. OPERATIONS ON THE OCULAR MUSCLES.

Strabismus.

THE correction of strabismus, whether it be paralytic or of the more frequent concomitant variety, often, but not always, requires operative intervention. Operative procedures should always be based on accurate examination. The question which of the two varieties of strabismus is present must be accurately determined (see my *Atlas and Epitome of External Diseases of the Eye*, second edition, p. 73), and in the case of concomitant squint it must also be determined whether it is convergent or divergent, with or without simultaneous upward deviation, whether the squint occurs only periodically or is constant, whether it is unilateral or alternating (now on the right and now on the left side), the magnitude of the squint angle, the condition of visual acuity and the refraction of both eyes (either in the erect image or with the shadow test), and the movability of the globes (as regards abduction, convergence, etc.).

It is an important principle in the treatment of strabismus never to operate until every other mode of treatment has failed—*i. e.*, in case of paralytic squint, causal treatment; and in case of convergent squint, suitable exercises and the necessary correcting glasses. In concomitant, divergent squint, operation, it is true, is the only effective treatment; something, however, can be done for this variety of squint, which in many cases is combined with myopia, by ordering the necessary concave lenses. Con-

vergent strabismus, on the other hand, which occurs more commonly in hypermetropia, and in many cases is probably enhanced by increased accommodation and the associated increased convergence, is often favorably influenced by convex lenses which neutralize the refractive error. In both varieties of strabismus, astigmatism must be corrected at the same time, so as to give both eyes the best possible far and near vision and thereby render binocular vision as perfect as possible.

If this treatment fails and operation has to be resorted to, the operator must never overlook this important rule: The operation must be such as not to diminish the mobility of the globe in the domain of the corrected muscles.

The fundamental principle of a strabismus operation consists in advancing the muscle, if its action is to be increased, and moving it back if its action, on the other hand, is to be limited. The procedure is confined absolutely to the tendinous insertions and their immediate neighborhood. Division of the muscle, which was recommended by Strohmeyer, and first performed by Dieffenbach in 1839, was incorrect because it put the muscles out of action. It was this method that brought discredit upon strabismus operations until Bonnet, Böhm, Guérin, and especially A. von Gräfe, later also Critchett, A. Weber and others established the operations of tenotomy and advancement on a correct basis in harmony with the anatomic conditions. Even now, however, the operation for the correction of strabismus, taken in connection with the entire treatment of squint, is the subject which is most hotly discussed, and, if only the permanent results are taken into consideration, it is the least satisfactory of all operative procedures on the eye. The treatment is far from being simple, either in principle or in execution, as was formerly supposed when tenotomy, the simplicity of which can not be denied, was almost exclusively practised, and there is no doubt whatever that advancement, although more difficult and more unpleasant to the patient, deserves more consideration than it has so far received. In the

same way greater attention should be given to the suggestions of Javal, Priestley Smith and Worth, that strabismus be treated in early childhood with suitable correcting lenses and exercises, in order to maintain or restore central, so-called binocular, vision, and as a preparation for the permanent restoration to the normal, with or without operation.

With regard to the anatomic relations of the tendinous insertions of the muscles in the globe, the following is worth remembering: The internal and external rectus end in a slightly curved line (with a convexity toward the cornea); the inferior and superior rectus end somewhat obliquely in an irregular line, so that the distance between the insertion line from the cornea varies according to the point where it is measured. For example, in the case of the superior rectus the nasal end of the tendinous insertion is 6.5 mm., and the temporal end 11 mm., from the cornea, according to Motais (inferior, nasal 5.5; temporal 8). For practical purposes the following numbers, which are easy to remember, will suffice: right internal rectus 5 mm., inferior rectus 6 mm., external rectus 7 mm., superior rectus 8 mm., measured at about the center of the tendon.

It is also important that the tendons of the four straight muscles of the eye should not only be adherent to the sclera along the above-mentioned insertion line from 9 to 11 mm. in length; they must also be laterally in relation with Tenon's capsule, so that, when a tendon is only separated in front at its scleral insertion, it retracts only a short distance, say 4 to 5 mm., because of the above-mentioned attachment to Tenon's capsule, and the reduction in the power of the muscle is therefore correspondingly moderate, and the gain to the antagonist correspondingly small, if the latter possesses the strength to rotate the bulb a corresponding distance over to its own side. The effect of separating the tendons on the position of the eye, therefore, depends very largely on the contractile power of the antagonistic muscle. The retracting tendon then forms a fresh adhesion with the sclera.

The preparations for a strabismus operation consist in cleansing, local anesthesia by the injection of 2 drops of a 2 per cent. cocain solution with a drop of adrenalin under the conjunctiva (if necessary general anesthesia, see p. 26), and a delay of five to ten minutes, during which the eyeball is subjected to gentle massage.

There is no ground for the objection that has been made against injecting cocain in this way—that it greatly disturbs the topography of the operative field; while, on the other hand, it is most agreeable for the patient, espe-

FIGS. 87–93.—Instruments for tenotomy:
FIG. 87.—Clark's eye-speculum (Weiss, London).
FIG. 88.—Straight conjunctival forceps.
FIG. 89.—Strabismus-hook, large.
FIG. 90.—Strabismus-hook, small (Stevens).
FIG. 91.—Strabismus-scissors, bent, with the blunt ends.
FIG. 92.—Strabismus-scissors, straight (Stevens).
FIG. 93.—Needle-holder (Sands).

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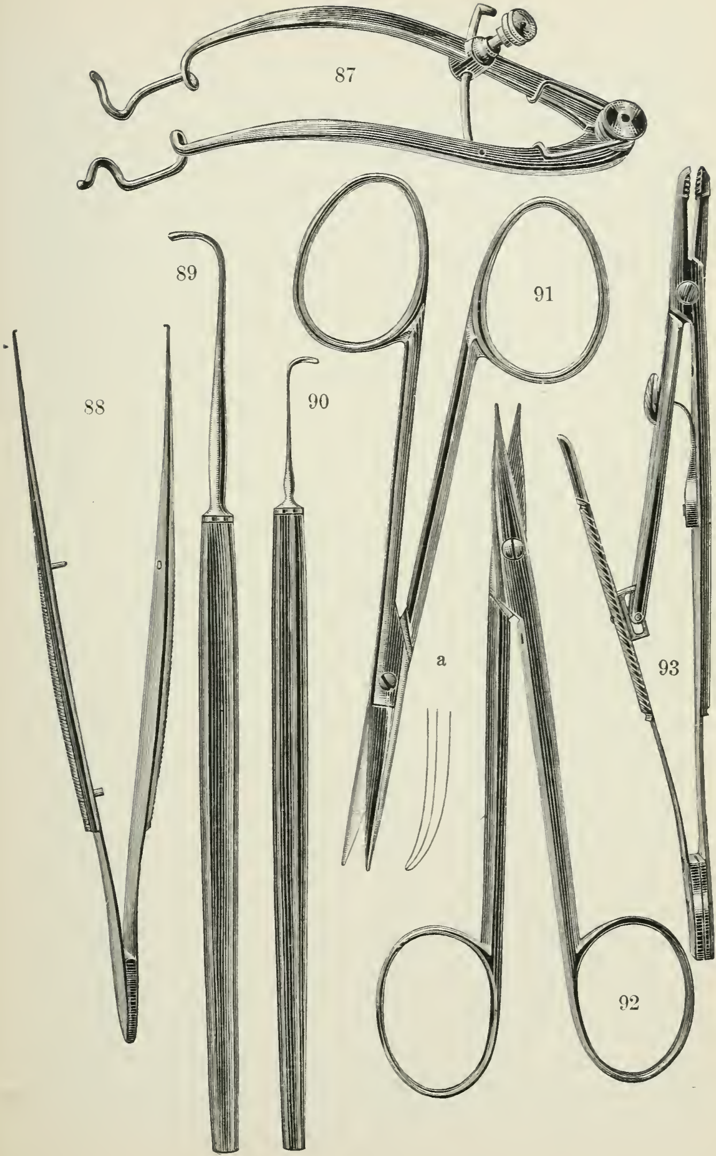
cially in the case of children, and, as it prevents all the struggles that are otherwise apt to take place, it is an important aid in guarding against any interruption of the operation. In the case of excitable children, who sometimes become unmanageable, even when they do not suffer pain, it is well to have the bent forceps (Fig. 22) ready, so that, if necessary, the assistant may rotate the globe toward the proper side and, especially in tenotomy of the internus, provide easy access to the insertion of the tendon. For the rest, the instruments shown in Figs. 87 to 93 are necessary or, at least, desirable for the operation. It is most important never to use sharp scissors for tenotomy, on account of the danger of injuring the sclera. It must also be borne in mind that the sclera underneath the muscular tendons may not be more than 0.2 mm. in thickness.

The operator takes up his position in such a way that the insertion of the tendon which is to be cut is opposite his right hand—that is, when the left internal rectus is to be cut, he stands to the left of the patient.

(1) **Tenotomy after von Gräfe.**—A vertical incision 5 to 6 mm. in length is made in the conjunctiva between the cornea and the insertion of the tendon, the cornea is picked up with a sharp forceps (Fig. 88), and a vertical incision is made between the cornea and the tendon. The membrane is then thoroughly undermined with the scissors in the direction of the muscles. This is particularly necessary in case of tenotomy of the internal rectus, to guard against the cornea being subsequently drawn back by the retracting muscle and causing a disfiguring deepening of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the inner canthus. The conjunctiva should be well undermined with the scissors as far as the caruncle. It must also be undermined in the direction in which the strabismus-hook is to be introduced under the muscle—that is, in the case of the left internal rectus, above the tendon, so as to make room for the hook—the peripheral edge of the conjunctival wound being constantly elevated with the forceps, which is also kept up while the strabismus-hook (Fig. 89) is introduced. To make sure that the hook gets under the tendon, it is first pushed under the conjunctiva with the point away from the tendon—for example, in tenotomy of the left internal rectus it is directed toward the forehead. It is then rotated so that the point is pressed somewhat vigorously against the globe and thus glides under the tendon, at the same time transfixing Tenon's capsule to one side of the tendon. This is the most important step in the operation. It is more likely to succeed if the bulb is rotated toward the side of the antagonistic muscle, either in response to command or passively by the curved forceps in the assistant's hand. If the hook has seized the tendon properly, some resistance is felt as the instrument is drawn forward. The handle is then changed from the right to the left hand, after the forceps has been laid down; and with the strabismus-scissors the tendon is then divided in a manner similar to that shown in Plate 8, except that in that illustration the instrument is a double hook and the wound is larger than in the case of tenotomy. With the same hook or with a smaller one (as for example, Stevens', Fig. 90) the operator makes sure that he has not left either above or below, at the insertion in the tendon, a small portion of tendon fibers; if any are found, they are, of course, to be divided. He also makes sure that the tendon does not possess a second, less perfectly developed, attachment to the sclera farther back, formed by a few fibers of connective tissue passing through the lower surface of the tendon to the sclera. These, if they are present, must also be divided, otherwise the operation is unsuccessful.

It may also appear, when the effect is tested—which must be done immediately after the operation—that the separation has been incomplete. The mobility of the eye is examined. If it is found that the excursion toward the side of the tenotomized muscle is as great as it was before, the wound should be examined to determine whether some portions of the tendon have escaped division. If the operation has been properly performed, a moderate diminution in the mobility, proportionate to the tenotomy, is observed. This reduction must not be too great, however. After tenotomy of the internal rectus the patient should have sufficient convergence to enable him to see the operator's finger, held in front of him at a distance of about 12 cm., with both eyes. If too much of the tendon has been separated from its lateral connections with Tenon's capsule, as may happen if the hook is handled too roughly or the lateral connections of the tendon are separated with the scissors—resulting in a faulty reduction of mobility—the effect of the tenotomy should at once be counteracted by inserting a restraining suture through the side of the tendon and including Tenon's capsule, drawing the latter, as well as the tendon, forward. The gaping wound in the conjunctiva is now closed merely with a superficial suture, as at the end of a regular operation. The suture may be rendered still more effective by introducing two needles, one above and the other below the tendon, through conjunctiva and Tenon's capsule and then through the zone of conjunctiva, between the cornea and the wound; the needles are then removed and the suture tied.

A single bandage and a few hours' rest are indicated, although, if necessary, the operation may be performed on walking patients. [The editor believes that both eyes should be bandaged; or better, if possible, the correcting glasses should be worn without a bandage immediately after the operation.—Ed.]

(2) **Tenotomy after Arlt** is performed as follows: The eyeball having been rotated toward the side of the

FIG. 94.—de Wecker's hooks for muscle advancement.
FIG. 95.—Prince's forceps for muscle advancement.
FIG. 96.—Angular (raven-beak) scissors for dividing the tendon (Landolt).
FIG. 97.—Needle-holder (Weiss, London).

antagonist, the conjunctiva is seized with a sharp conjunctival forceps, a little to the corneal side of the insertion of the corresponding tendon, and drawn slightly away from the globe. The fold thus produced is then nicked with strabismus-scissors, and the opening enlarged upward and downward, so as to make a vertical wound from 8 to 10 mm. in length; from this wound the conjunctiva is then undermined in the direction of the tendon. The tendon is then seized with the same sharp forceps, which is held perpendicularly to the globe. The tendon is also lifted slightly away from the globe and divided with the scissors close to its insertion. The strabismus-hook is then introduced to make sure that none of the fibers of the tendon has escaped. The effect of the operation is then tested and, if necessary, corrected as in the foregoing operation; or the operation is terminated at once. A suture is inserted in the conjunctiva, and the after-treatment is the same as in the foregoing operation.

(3) **Tenotomy after Snellen** is similar to the foregoing. Snellen makes a horizontal incision in the cornea, over the center of the tendon (as von Gräfe occasionally did and advised); undermines the mucous membrane laterally on both sides and in the direction of the tendon (in the case of the internus as far as the caruncle), seizes the tendon with the conjunctival forceps; and first makes a small opening at the center of its insertion. Introducing the scissors through this opening, he then gently pushes the instrument well under the insertion of the tendon, both above and below, so as to divide the tendon with the least amount of damage and without distorting or displacing it. The after-treatment is the same as in the foregoing operation.

Tenotomy, which restricts the sphere of action of the

94

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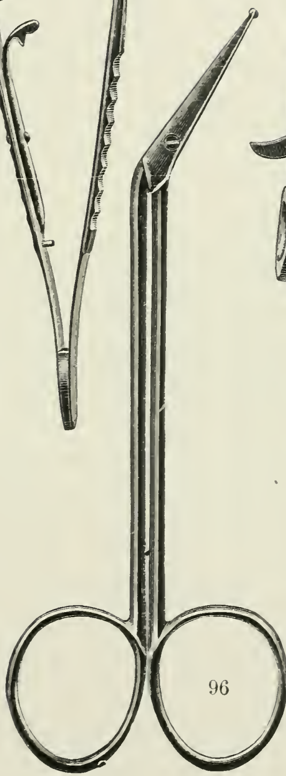

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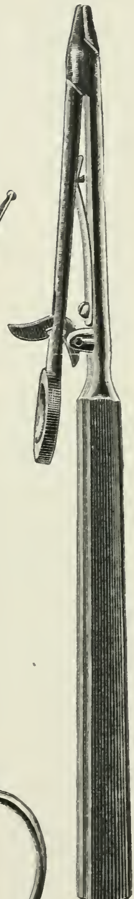

97

muscle, often needs to be combined with an operation to increase the action of the corresponding antagonist. Thus, in severe cases of divergent squint, unilateral or bilateral tenotomy of the externus would not accomplish the desired result if one or both inward rotators were not also utilized to correct the condition, and the same is true of the outward rotators in the case of severe convergent squint. Such an operation to increase the action of a muscle is indicated specially in paralytic squint and when, as a result of strabismus of long standing, the action of the antagonist of the squinting muscle, abduction in convergent squint, has become very deficient. The corrective operation may also become necessary to advance a muscle that has receded too far after tenotomy or myotomy, and to strengthen its action.

This latter indication led to the development of advancement of tendons, which was performed in the early days of strabismus operations to correct the movements of an eye that had been damaged by myotomy (instead of tenotomy) and had developed strabismus of the opposite type. Dieffenbach treated this secondary form of strabismus by searching for the retracted muscle and fastening it, by means of a suture, to the anterior portion of the globe after it had been rotated inward; or, by freshening the edges, united the muscle with a fine suture—that is to say, he attached the abnormally retracted muscle to its tendon.

Guérin in 1849 and, later, von Gräfe, brought the retracted muscle forward by searching for it and separating it from the globe. The eye was then rotated toward the muscle which was to be advanced until the insertion corresponded with the cornea—that is to say, it was advanced beyond the true insertion. Rotation was effected by means of a suture in the manner already practised by Dieffenbach, Guérin passing the suture through the conjunctiva to the temporal side of the cornea, while von Gräfe did a tenotomy on the abducens and attached the suture to the tendon stump. By means of this suture, which was fastened to the root of the nose with adhesive plaster, or, in the case of abduction, to the cheek, the eye was maintained in the forced position for several days, during which a bandage was applied in order to compel the retracting muscle to form a new insertion in front. But as, like every other muscle, it was apt to contract, it sometimes grew fast too far back on the globe, in spite of this precaution. This operation, which causes the patient pain and compels him to keep quiet for several days, was known as the suture operation. It was compelled to yield the floor to actual advancement and suturing of the tendon, which was first performed by Dieffenbach and then elaborated by Critchett, von Gräfe,

Knapp, Weber, de Wecker, and many others. Critchett suggested as an improvement the introduction of 3 sutures. He made a vertical incision in the conjunctiva, between the cornea and the tendinous insertion, and through it introduced a strabismus-hook behind the tendon, thus separating it from the sclera. He then cut away a strip from the peripheral edge of the wound and united it by means of 3 sutures introduced in a horizontal direction above, at the center and below, including the piece of conjunctiva remaining at the corneal margin and taking a deep hold on the peripheral edge of the wound. When the three sutures were tied the tendon was drawn forward almost as far as the corneal margin.

Operations on the Antagonist of the Squinting Muscle.

1. **Knapp's Method.**—In order to make sure of the effect of the advancement, Knapp does a thorough tenotomy on the squinting muscle, and then introduces the sutures toward the equator, through the tendon and conjunctiva. He inserts 4 to 6 sutures through the conjunctiva, the subconjunctival, and part of the scleral tissue, the intermediate ones near the horizontal meridian, and the upper and lower ones to one side and above and below, respectively, near the vertical meridian of the eye.

2. **Weber's Method.**—Ad. Weber, in his advancement method (1873), followed the principle of drawing the tendon forward toward the cornea in a perfectly uniform manner, avoiding any irregular traction of the sutures and, therefore, any upward and downward displacement of the tendon. After making a vertical incision in the conjunctiva in front of the line of insertion of the muscle to be advanced (between the line of insertion and the cornea), and undermining the conjunctiva to a point beyond the tendon, he separated the latter from the sclera by seizing it with forceps and holding it while the suture was passed through the center of the tendon, going in from the scleral side. A long suture provided with a curved needle at each end is folded in the middle and passed double through a third needle. By means of the third needle the thread is introduced into the tendon and, a little farther back, through the conjunctiva as well (Fig. 98, *a*). While the loop, which thus comes to the surface,

FIG. 98.—Methods of advancement:
(*a*) After Ad. Weber.
(*b*) After de Wecker.
(*c*) After Prince (see Plate 8).
(*d*) After Verhoeff.
(*e*) After Verhoeff.
(*f*) After Worth.

Whenever the suture is covered by tissue it is indicated in the schematic drawings by dotted lines.

is secured by the assistant, and, after the needle has been removed, the operator carries the lower end of the suture between the conjunctiva and the sclera as far as the vertical diameter of the cornea and far enough (2 to 3 mm.) from the corneal margin so that the thread, when it is stretched, will not touch the cornea. The same thing is then done with the upper half of the suture. The two ends of the suture are then passed through the loop in the tendon, drawn tight, and ligated after the tendon has been drawn forward as far as necessary. But the knot must not slip through the loop, else the entire suture comes out. It is, therefore, better to modify Weber's method by passing the two ends of the suture in opposite directions through the loop, so as to tie the loop in with the knot. I saw Horner perform this modification in 1877, and Fröhlich, who very frequently used this method of advancement—with a few additional modifications (horizontal incision in the cornea, stretching of the muscles—also ligated the sutures in this way. He thinks very highly of this operation on account of its simplicity, its practically uniform success, and its wide range of applicability.

3. **de Wecker's method** of advancement is similar to that of Weber. The double hook which he designed (Fig. 94) is very useful, both for his own and for other methods of advancement. By means of it the tendon can be securely held, and it is possible, by holding the tendon away from the globe after it has been separated, to insert a needle through the lower side at any desired distance from the anterior extremity of the tendon. de Wecker introduces the needle in this direction after threading it

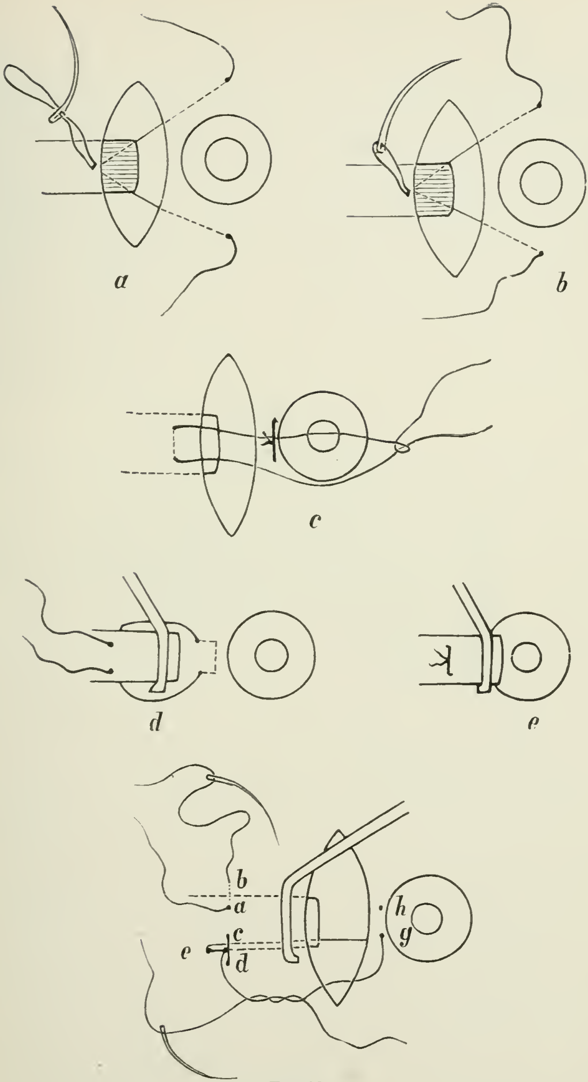

FIG. 98.

with a single suture (Fig. 98, *b*) and drawing it halfway through, so that the needle is at the center of the suture. The ends of the suture are then again provided with needles. After the middle suture has been introduced through the tendon and the conjunctiva from the scleral side, the needle is cut away so that, instead of Weber's loop, there are left two free ends emerging from the tendon and conjunctiva. These two ends are then tied with the other ends of the suture, which have been passed through the conjunctiva, above and below the cornea, in the same way as in Weber's operation. The operator must be careful to make equal traction on the two sutures, otherwise the muscle will be displaced upward or downward.

4. **Landolt's advancement** resembles de Wecker's in so far as a suture is passed through the tendon from in front, above and below the cornea; but each suture is introduced separately (Fig. 99). After making a large conjunctival flap, so that the wound extends almost to the cornea, the apex of the flap is trimmed off and an incision is made in Tenon's capsule, close to the tendon, through which the hook is introduced and pushed underneath the tendon. Two sutures are then introduced through the tendon, as shown in Fig. 99, the exact site being determined by the degree of advancement that is desired. If the sutures are introduced as far back as shown in Fig. 99, the tendon is divided at a point slightly in front of the suture (Landolt uses the scissors shown in Fig. 96), and the piece of tendon is then cut away as far as the insertion —that is to say, the tendon is shortened by 3 to 5 mm. In order to be able to attach it in front, the conjunctiva and subconjunctival tissue are then seized with the conjunctival forceps in the direction of *a* to *b*, and the needle of the corresponding end of suture is introduced as deeply as possible through the fold thus formed, making it penetrate into the episcleral tissue. The introduction of the suture is slightly facilitated by the fact that the conjunctival forceps has oblique serrations which project beyond the

point and therefore takes a better hold on the tissues. If it appear that the suture has not a deep-enough hold on the tissue, matters may be improved by seizing another fold of conjunctiva and episcleral tissue in a direction perpendicular to *a* to *b*, and again introducing the needle. When these sutures have been placed, the assistant rotates the bulb toward the side of the muscles to be advanced, using a fixation-forceps; whereupon the sutures are tied

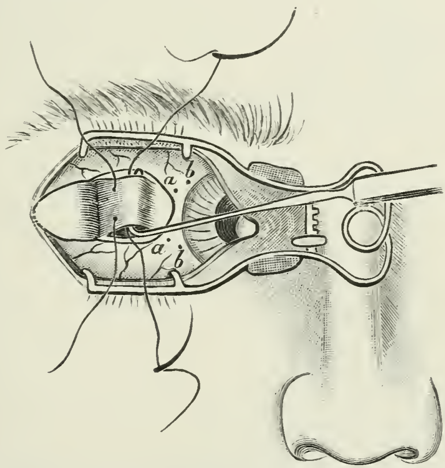

FIG. 99.—Advancement of the abducens after Landolt: The tendon has been slightly raised with a simple hook. The needles are later introduced from *a* toward *b* (see the text).

without any traction having been made on the tendon or on the conjunctival sutures.

In the following methods of advancement the object is to make the approximation of the tendon to its new place of insertion somewhat more certain than in those described so far; the sutures are not introduced blindly, and the operator is not obliged to grope his way, more or less, in the dark underneath the conjunctiva.

5. **Prince's operation** is performed as follows: A

Plate 8.

Advancement of the right internus in divergent strabismus, after Prince. The suture in the sclera, to which the tendon is afterward fastened, is seen lying along the corneal margin. The tendon has been seized de with a Wecker's double hook, and the operator is about to separate it from the sclera.

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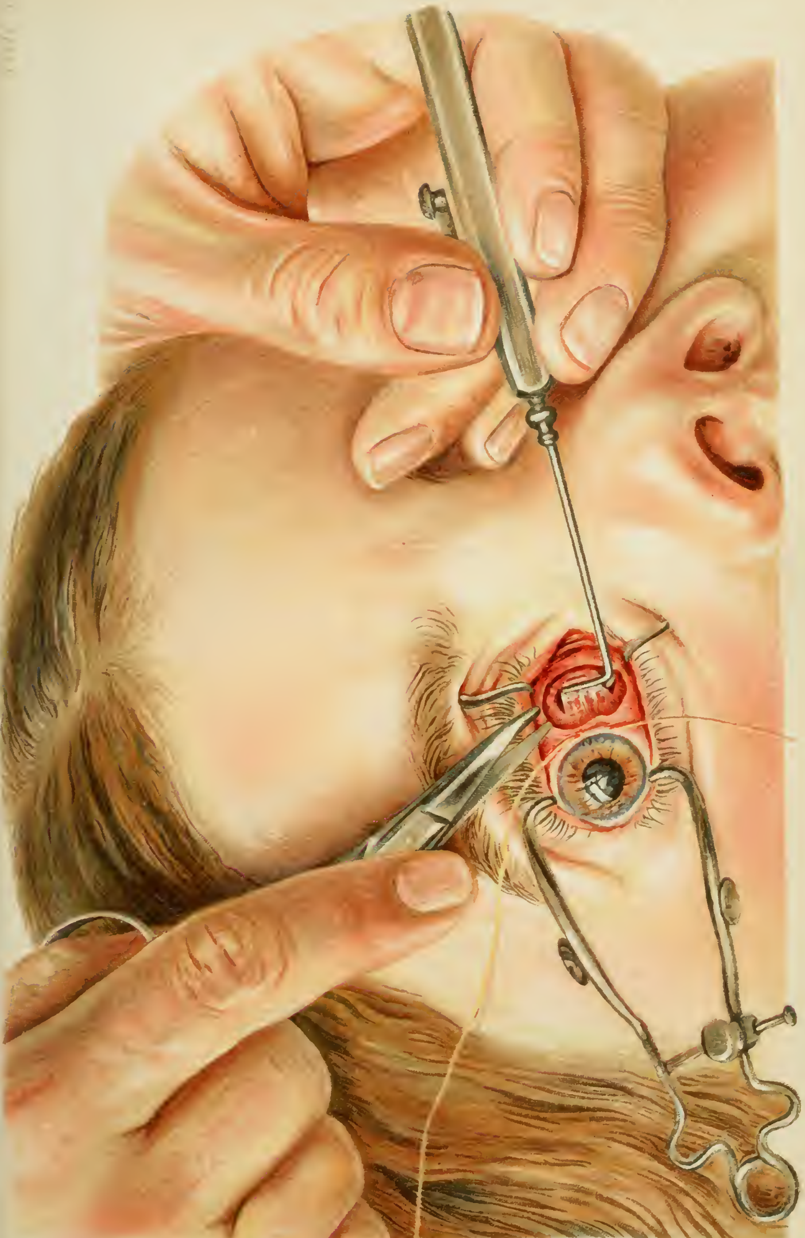
suture, armed with a sharp needle, is introduced at the corneal margin, transfixing the conjunctiva, subconjunctival tissue, and superficial layer of the sclera (see Plate 8), while the globe is prevented from rotating with a broad fixation-forceps. To this suture the tendon is afterward attached. The latter is exposed, by means of a vertical incision in the conjunctiva, and grasped, either with a Prince's forceps or, as shown in Plate 8, with a de Wecker's double hook, and divided, after which the tendon is seized with a suture, armed with two needles. Each of these needles is then introduced from below upward at some point on the posterior portion of the globe, taking in tendon, capsule, and conjunctiva, one on each side of the median line of the tendon and about 4 mm. apart. One of the ends of the suture is then laid square across the cornea, so as to cross the suture which has been introduced at the corneal margin, and which is then tied over the other suture (Fig. 98, *c*). The other end of the suture, which passes through the tendon, is then laid over the former and tied, drawing the tendon and, with it, the conjunctiva forward as far as the fixation-suture.

I have used this method of Prince's almost exclusively for many years whenever I have had to do an advancement, and have always had good results with it. Occasionally I modify the ligation of the sutures by simply tying the two ends of the suture which passes through the tendon with the two ends of the fixation-suture, the operator and the assistant making uniform traction on the sutures. In this way the tendon is spread out a little more as it is drawn forward.

6. In **Verhoeff's operation,** which results in a very strong attachment, a vertical incision is made in the conjunctiva at a distance of 3.5 mm. from the cornea; the conjunctiva is undermined as far as the cornea; the tendon is sought for, divided from its lateral attachments with the



capsule, and grasped with a Prince's forceps (Fig. 98, *c*). If necessary, the squinting muscle may then be tenotomized. The edge of the conjunctiva remaining along the cornea is dissected back as far as the latter membrane, and a suture with a needle at each end is then introduced vertically a distance of 6 to 8 mm. through the superficial layer of the sclera, at a distance of about 1 mm. from the corneal margin, in the portion of the sclera which has been exposed by the dissection. The needle is to be reintroduced at the point of exit and carried a short distance in a horizontal direction. The same thing is then repeated at the point of entrance with the second needle. The two needles having been passed through the tendon at some point behind the scleral side, the assistant grasps it with a clamp and draws it forward as far as necessary to bring the desired part on the scleral suture, which is then tied (Fig. 98, *e*). The piece of tendon contained within the clamp is then resected, the remainder — between the suture and the cornea—is pushed under the conjunctiva, and the membrane united over the suture. The conjunctival suture may be remove after four days, the one in the tendon after seven days. The needles used for introducing the suture into the sclera should not be too long and not too sharply curved at the point. The suture must not be too thick.

7. With **Worth's method** of advancement, that portion of the suture with which the tendon is seized is secured as firmly as possible by including the adjoining Tenon's capsule along with the tendon (Fig. 98, *f*), access having been obtained to the insertion of the tendon through a vertical incision in the cornea about 10 mm. in length. A Prince's clamp is applied behind the insertion in such a way as to include Tenon's capsule and the conjunctiva over the tendon. After the tendon has been divided from the scleral side, it may be raised sufficiently, by means of the clamp, to permit of the introduction from within outward of a suture through conjunctiva, capsule and tendon, which is made to emerge at *b;* the other edge of the tendon is seized in the same way and the suture (*cd*) is tied.

Hence, one of the sutures hanging from the knot is without a needle, while the other has one. The latter is then introduced a little behind the knot at *e*, from without inward, and passing through conjunctiva, capsule and tendon, carried forward underneath the tendon toward the cornea, and made to emerge at *g*, after passing through the edge of conjunctiva and the subconjunctival tissue. The same thing is done with the suture at the other edge of the muscle. The two sutures—that which has been left hanging from the knot in the tendon and that which has passed forward through the limbus of the sclera—are then tied.

Worth attaches a great deal of importance to the quality of the thread, which must not be too thin, and which he prepares very carefully by drawing it through a boiling mixture of beeswax (3 parts) and white vaselin (5 parts), and keeps in a sterile vessel.

One sometimes has the unpleasant experience in doing an advancement of having the suture cut through the tendon or through the conjunctiva in front. Often the tendon of a muscle which is to be advanced is atrophic, thin and narrow, and does not afford sufficient hold for the suture, especially when the latter is merely passed through the body of it. The conjunctiva and the episcleral tissue also may not always be sufficiently robust to resist the constant traction exerted by the muscles on the suture. If the stitch cuts through, the result, unfortunately, is that the advancement becomes converted into a condition of more or less marked retraction.

These considerations suggested different methods to secure the same result as were obtained by advancement, which are: (1) making a fold in the muscle or tendon, without separating the latter from its insertion; (2) resection and actual suturing of the tendon, thereby also effecting a shortening of the tendon or of the muscle.

8. **Capsular Advancement after de Wecker.**—In this operation the tendon is folded as described above, and Tenon's capsule is drawn forward. Since 1888 the originator has used this method exclusively instead of his

muscle advancement (described on p. 250). Instead of a vertical, a curved incision is made about 10 to 12 mm. in length in the conjunctiva, running parallel to the cornea and a few millimeters from its margin. When it is desired to obtain a very marked effect, a crescentic piece of conjunctiva is excised by means of a second curved incision.

A vertical slit, a few millimeters in length, is then made in the capsule, both above and below the tendon and in the direct prolongation of the line of insertion. Through these two openings the capsule, as well as the tendon, is undermined with closed scissors, and any adhesions between the latter and the sclera are divided. Through these openings in the capsule the sutures are then introduced, one of the two needles of a doubly armed suture being introduced in the upper, and one in the lower, opening and brought out underneath the tendon, 5 to 8 mm. behind the insertion, transfixing the tendon and conjunctiva. The two stitches should be 3 mm. from the edge of the tendon and 3 mm. apart. The other needle is introduced into the aforesaid opening in the capsule and carried forward, under the conjunctiva, in the superficial tissue of the sclera as far as shown in Fig. 98, *b*. The upper and the lower sutures are then tied, while at the same time that portion of the tendon which is transfixed by the two fastenings is drawn forward along with the capsule and the conjunctiva. In other words, a fold is made in the tendon, since the original insertion is retained. The operation is in every way analogous to de Wecker's method of advancement, which has been mentioned, except that the tendon is not separated from the conjunctiva.

9. **Knapp's Method.**—Knapp modified his method of advancement (see p. 249) in a similar manner—that is, he introduced the sutures in almost the same manner, but does not separate the tendon, so that he also makes a fold in the tendon and in the capsule, since the posterior portion of the tendon, which is seized by the stitches, is drawn forward over the insertion.

10. Certain American authors are even more radical in their efforts to bring about a duplicature of the tendon. Thus, **Todd,** for example, after freely exposing a considerable portion of the tendon by means of a flap incision through conjunctiva and capsule, performs an actual folding over by means of a fork-shaped instrument and fixes the duplicature with two catgut sutures. The "tendon folder" is so constructed that the two arms can be approximated by means of a screw, and its action may be compared to that of a two-tined fork, one tine of which would be placed on the tendon near the insertion, while the other is placed underneath the tendon behind it. If the fork were turned about its long axis, the posterior portion of the tendon would come to lie on the anterior portion. After tying the two catgut sutures, Todd further secures the duplicature with two silk sutures, which include the conjunctival flap, and are brought out in front, a little to one side of the cornea, in a manner similar to that employed in de Wecker's advancement.

11. **Brand** adopted yet another method of making a duplicature. After freely exposing the tendon between two ordinary strabismus-hooks, he inserts a particularly heavy strabismus-hook (2 to 2.5 mm. in thickness) underneath the tendon, between the other two hooks, and introduces sutures underneath the large hook, so that the tendon is shortened by an amount equal to the part that has been elevated with the large hook.

12. **Schweigger's Method.**—Resection of a stretch of tendon as long as the necessities of the case require, followed by suturing of the ends is a method that has been chiefly cultivated by Schweigger. His operation for "advancement" is performed as follows: After tenotomy of the squinting muscle, the conjunctiva is incised directly over the tendon of the antagonist in a line parallel to the tendon, the incision being carried through the tissues of Tenon's capsule. An unprotected hook, curved on the flat, is then pushed under the muscle, and the latter elevated. Tenon's capsule, which is usually raised at the

same time at the edge of the muscle, is first transfixed with a hook and then dissected away until the entire tendon lies free on the hook. To make sure of this, it is better to introduce a second hook under the muscle in the opposite direction. While one hook is left under the tendon, the other is pushed along the muscle to the point where the sutures are to be introduced. Hence the tendon and the muscle are completely laid bare for a distance of from 3 to 10 mm.

With the aid of a scale, with which the length of the piece to be excised is determined, the catgut sutures are placed in such a way that one of the needles is introduced at the point that has been measured, from underneath the upper edge of the muscle, carried forward from the posterior to the anterior side and brought out below the middle of the muscle. The entire muscle is thus ligated and divided in front of the sutures. Each suture has two needles, the second of which is used to fasten the divided muscle in front to the tendinous insertion or to the tendon-stump that has been left at the insertion. A piece may be excised from the muscle that is to be advanced if the muscle has been ligated at some distance behind the tendon; for it is not necessary to leave more of the muscle on the tendon than is required to furnish a good hold for the suture. As a rule, the excision of a piece of muscle is unnecessary.

13. **Koster's method** of advancing the tendon is quite similar to Schweigger's, except that he does not divide it. He thus effects a duplicature of the tendon.

14. On the other hand, **L. Müller** recommends actual *myectomy*, like the operation of suturing tendons performed by the surgeons, but accompanied by tenotomy of the squinting muscle; while Vieusse and Noyes-(Detroit), who were the first to practise excision of a piece of the tendon, do not correct the squinting muscle. Müller points out that advancement of the muscle is a very imperfect operation and has no analogue in general surgery. He says it is impossible to tell how much the movable

conjunctiva will yield to the tonic pull of the distended muscle during the hours immediately succeeding the operation, and that is why the operator always tries to get a much greater effect than he ultimately wants, because he does not know how much of the primary effect will be lost. He also thinks it is very important to leave the insertion of the tendon in the bulb intact, so as to avoid displacement of the tendinous insertion if the line of union turns out crooked; such a dislocation is very easily produced during the operation for advancement and may cause upward or downward deviation of the globe.

The operation should be performed under anesthesia, so that the muscles may be relaxed. A vertical incision is made in the conjunctiva, 4 mm. from the cornea, and the mucous membrane dissected away sufficiently to leave the muscle fully exposed. A strabismus-hook is then placed underneath the muscle, and its lateral connection with Tenon's capsule divided with scissors as far back as the length of the piece of muscle that is to be excised, which in divergent squint may be 6 mm. in length and equivalent to the degree of deviation—in divergent squint, 1 to 2 mm. greater; and in convergent squint, 1 mm. less. This length is laid off on the muscle with a pair of dividers, taking care to leave a piece 2 mm. in length attached to the sclera in front. Behind the piece that is to be excised a moderately heavy silk suture is introduced at the upper, and another at the lower, edge of the muscle, taking in about $\frac{1}{4}$, and tied with a surgical knot to prevent slipping. Hence, there are two free ends at the upper and two at the lower edge of the muscle; and of each pair one is cut off close to the knot. The muscle is then divided in front of the sutures and the anterior piece amputated, all but the above-mentioned stump, which is 2 mm. wide. Two corresponding sutures are then introduced into this stump in the same way as in the muscle; and the two upper, and then the two lower, ones tied with surgical knots. Whenever the tension is found to be very great—when the stitches in the tendon are brought

together—Müller adds an ordinary tendon-suture, after Wölfler, through the middle portion of the muscle. The conjunctiva is then closed over all by means of two sutures. The tendon-muscle sutures heal into the wound and are not removed. Both eyes must be bandaged for three days.

Both operation and after-treatment must be conducted according to aseptic principles in all these procedures of advancement, duplicature or resection; special attention should be given to the sterilization of the suture material. But no matter how perfect the sterilization, a suture should never be passed completely through the sclera to the corneal margin, for after a few days the operative field ceases to be sterile, and there is every possibility of infection spreading along such a suture into the interior of the globe and doing a great deal of damage.

A good many operators recommend general anesthesia in cases of advancement. In regard to this point I adhere to the opinion which I expressed emphatically on page 27, and I may add that I have performed a large number of advancements with nothing more than cocain anesthesia during the last twenty years, and do not believe that I have had any worse results by so doing.

An operation for advancement is followed by a good deal of pain, which persists for several hours, and should be relieved by an injection of morphin.

Another unpleasant feature about this operation on the antagonistic muscles is the necessity of wearing a double bandage for several days to insure healing. In cases of advancement such a bandage must be worn for six to eight days; in duplicature or resection a few days less.

The redness and swelling which persist for some time after the advancement and duplicature always subside in the end. On the other hand, one can never be certain whether the sutures that have been left will become encysted or will be extruded after a period of weeks or months; an occurrence which the patient usually finds most unpleasant.

Müller has pointed out that the only effect of advancement is to shorten the muscle; for the advanced muscle probably grows fast to the bulb, along the entire interval between the side of the wound and that of the old insertion, and does not unwrap itself from the globe even in extreme rotation. Hence, the advanced muscle is practically inserted at the side of the original tendinous insertion.

Later, it was actually proved by Fröhlich that such is actuallv the case. Five weeks after advancement, to a point in front of the original (normal) insertion of the corresponding advanced muscle, he cut down vertically as far as the sclera, so that that portion which had been advanced beyond the original insertion was completely separated from the rest of the muscle. But the effect of the operation was in nowise impaired, nor did he find a free space between the advanced terminal portion of the muscle and the globe.

With regard to the indications for the different kinds of operations performed for the correction of strabismus, it may be said that the divergence of opinion is still very great. Opinions differ widely even with regard to the age at which they may be undertaken. As convergent squint in children occasionally disappears as they grow older, many operators maintain that no operation should be performed for the correction of this variety of strabismus before the fourteenth to the sixteenth year. Others recommend an early one in order that binocular vision may be established as soon as possible. There is no doubt that in cases of convergent squint in children one has to be very careful not to overcorrect the error and cause subsequent divergent squint, which is quite apt to develop in cases of this kind, especially when the tenotomy has been radical. Earlier than the fifth or the sixth year surgical aid for the correction of convergent strabismus is not to be recommended, in my opinion; after that year one must be guided by individual conditions and by the severity and character of the anomaly. In general it may be said that the older the patient, the more radical may be the treatment. Especially in adults with marked strabismus no satisfactory result can be hoped for without thorough advancement.

In regard to the choice of operation in any given case of strabismus there is a similar difference of opinion, and theory and practice are also at variance. Most of the

procedures by which the antagonist of the squinting muscle is corrected by advancement, duplicature and the like, and which I have not by any means exhausted in the above list of 14, show that the task is not an easy one and that its solution does not always satisfy the operator. This is largely because all the sutures have to be introduced in soft, yielding tissue, and cut through, more or less, on account of the steady pull of the muscle. The firmer the anterior fixation of the suture, the more will the tendinous portion be endangered; and vice versa. To be moderately sure of a good result, both eyes must be completely immobilized for six or seven days, and this subjection to the discomfort of a double bandage is a very unpleasant concomitant of the operation. As the pull of the muscle is weakened by adding tenotomy of the squinting muscle to the advancement operation, the former is specially to be recommended whenever a marked degree of strabismus is to be corrected. Simple advancement without tenotomy, sometimes on both sides, has been chiefly recommended by Landolt for convergent squint in youthful individuals. It is quite conceivable that in this way there is less danger of overcorrection, and that mobility is better than when tenotomy is performed. On the other hand, I have seen exophthalmos develop after radical advancement without tenotomy of the squinting muscle, and the cosmetic effect was very bad.

As regards mobility, it should always be borne in mind that tenotomy must be performed with due caution and in such a way as not to impair the mobility of the globe in the domain of the tenotomized muscle; hence, the lateral attachments of the tendon with the capsule must not be injured. Too thorough correction should not be attempted with a single operation; it is better in cases of severe strabismus to distribute the effect over the two eyes. If the squinting persists, it is not advisable to subject the same muscle to a second tenotomy; in such a case one should always resort to advancement.

It has also been objected that tenotomy is followed by

protrusion of the eye and, when the internus has been cut, to disfiguring retraction of the inner canthus. So far as the last-mentioned disfigurement is concerned, it can be avoided by undermining the conjunctiva, as far as the caruncle, before doing the tenotomy and dividing it so as to separate its connections with the muscle, which may be expected to retract after it has been cut. The conjunctival wound must also be carefully united after the operation. If there is staring of the eyeball after tenotomy, it is a sign that the tendon has been too freely separated.

It is very difficult to know in advance how many operations will be required to correct a case of strabismus, and it is practically impossible to predict exactly what the ultimate effect will be. This is dependent not only upon how much of the tendon is separated from the globe, but even more on the strength of the antagonist and its ability to rotate the globe to its own side. But even with the most ingenious method of examination it is impossible to predict what the permanent strength of the antagonist will be, because in all these examinations it is only the momentary contracting power of the muscle that is tested, and a tenotomy or an advancement not infrequently in the end produces quite a different effect from the one that had been expected.

The treatment is most successful when it is conducted upon the same lines as orthopedic treatment, the correction being kept up cautiously until a satisfactory result is obtained. The operator should never allow himself to be beguiled into making any definite statement beforehand about the duration of treatment and the kind and number of operations that will be required.

In severe degrees of strabismus, especially in the divergent form, in which there is less danger of overcorrection or of the condition later changing to convergence, it is well not to separate too much of the tendon from the globe, and to combine tenotomy with advancement, making the latter as radical as possible. In most cases of convergent, as well as divergent, squint the ultimate effect is insufficient,

and the anomaly can, as a rule, be fairly well corrected by means of a tenotomy on the other eye. The operative treatment must be combined with the proper use of lenses and stereoscopic exercises.

If, after tenotomy and advancement have been done on the eye, there is only a slight deviation, and it is to be feared that a second tenotomy might produce an excessive effect, especially in cases of convergent squint, the primary operation may be supplemented by Verhoeff's operation for lengthening the tendon, which is only moderate in its effect. In this the tendon is lengthened, by means of incisions, without separating it from the globe (Fig. 100). Whether the result of this process is more permanent than that produced by partial tenotomies, which were formerly proposed and carried out by various authors, will have to be shown by future experience.

FIG. 100.—Verhoeff's operation for lengthening a tendon.

While the substitution of tenotomy for advancement would be a most welcome change, the difficulties in the way of its accomplishment, especially in children, are very great. In any case a tenotomy, if undertaken at all, should be performed in such a way as not to disturb the mobility of the globe. The weaker the muscle the more urgently is advancement indicated. For cases of paralytic squint it is the most important method.

ENUCLEATION OF THE GLOBE.

Complete removal of the eyeball from Tenon's capsule was first proposed by Bonnet, of Lyons, in 1841. It is based on his anatomic studies of the connective-tissue capsule of the eye, for which reason Tenon's capsule is also known as Bonnet's capsule.

When the eyeball is removed along with some of the appendages (as, for example, in the case of a tumor of the globe that has ruptured externally), the operation is called extirpation of the globe. When it is still more compre-

FIGS. 101–105.—Instruments used in enucleation:
FIG. 101.—Straight conjunctival forceps.
FIG. 102.—Blunt, curved strabismus-scissors; *a* seen from the side.
FIG. 103.—Strabismus-hook.
FIG. 104.—Heavy fixation-forceps for seizing the globe.
FIG. 105.—Heavy, curved scissors for dividing the optic nerve; *a* seen from the side.

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hensive and affects the entire orbit, it is known as exenteration of the orbit.

In cases in which the eyeball is greatly inflamed or adherent to its surroundings as a result of former inflammation or of subconjunctival injections of bichlorid, the preliminary treatment for enucleation includes whatever is necessary as a preparation for general anesthesia. (For the treatment in other cases the reader is referred to page 30.)

The instruments necessary for the operation will be found under Figs. 101–105. If Arlt's operation is selected, the strabismus-hook (Fig. 103) is not necessary; while, on the other hand, a heavy, straight pair of scissors, like that shown in Fig. 108, is required. Desmarres' retractors, as shown on Plate 9, are specially recommended to beginners, because an inexperienced operator is in great danger of cutting the lids in this operation; but specula like those shown in Figs. 14 and 33 can also be used.

Before beginning, especially if a general anesthetic has been given, the operator must carefully notice once more which eye is to be enucleated, to guard against the accident of removing the wrong one, which has happened more than once. The mistake is specially apt to happen when the eyes present the same external appearance, as when both are normal so far as external appearances go, or equally inflamed, as, for example, in sympathetic disease. Sometimes the mistake is due to the fact that the operator takes his position at the patient's head. Beginners ought to make it a rule to have the sound eye covered for some time before the operation with an occlusive bandage. [A mark with an anilin pencil should be made on the brow, over the eye to be removed.—ED.]

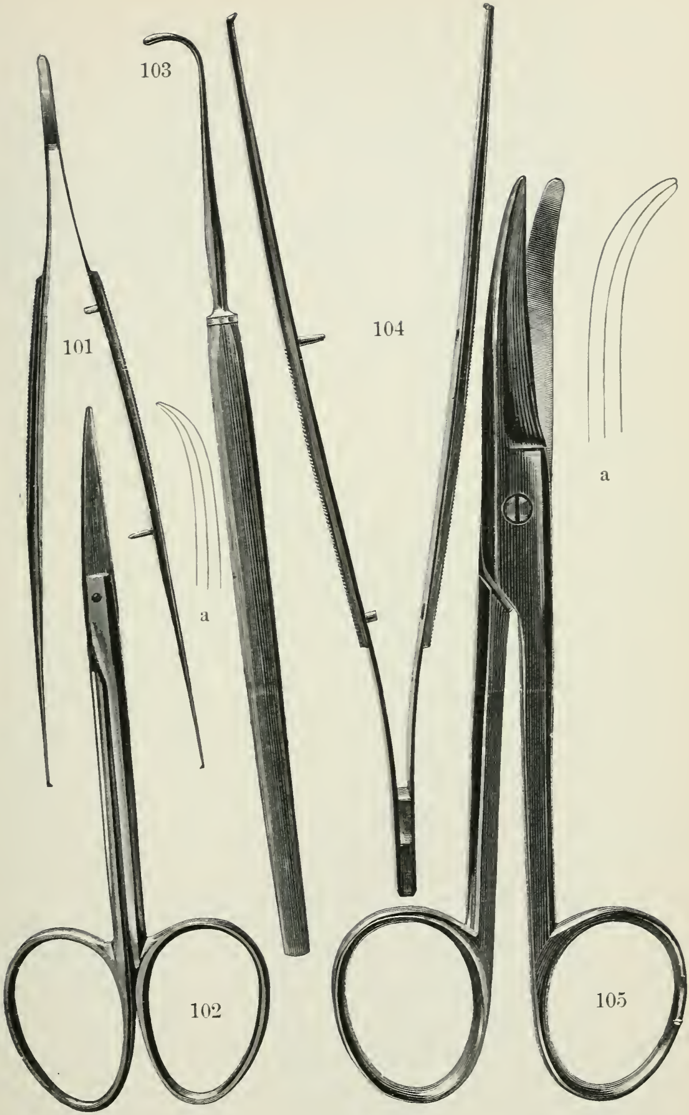

103
104
101
a
a
102
105

Plate 9.

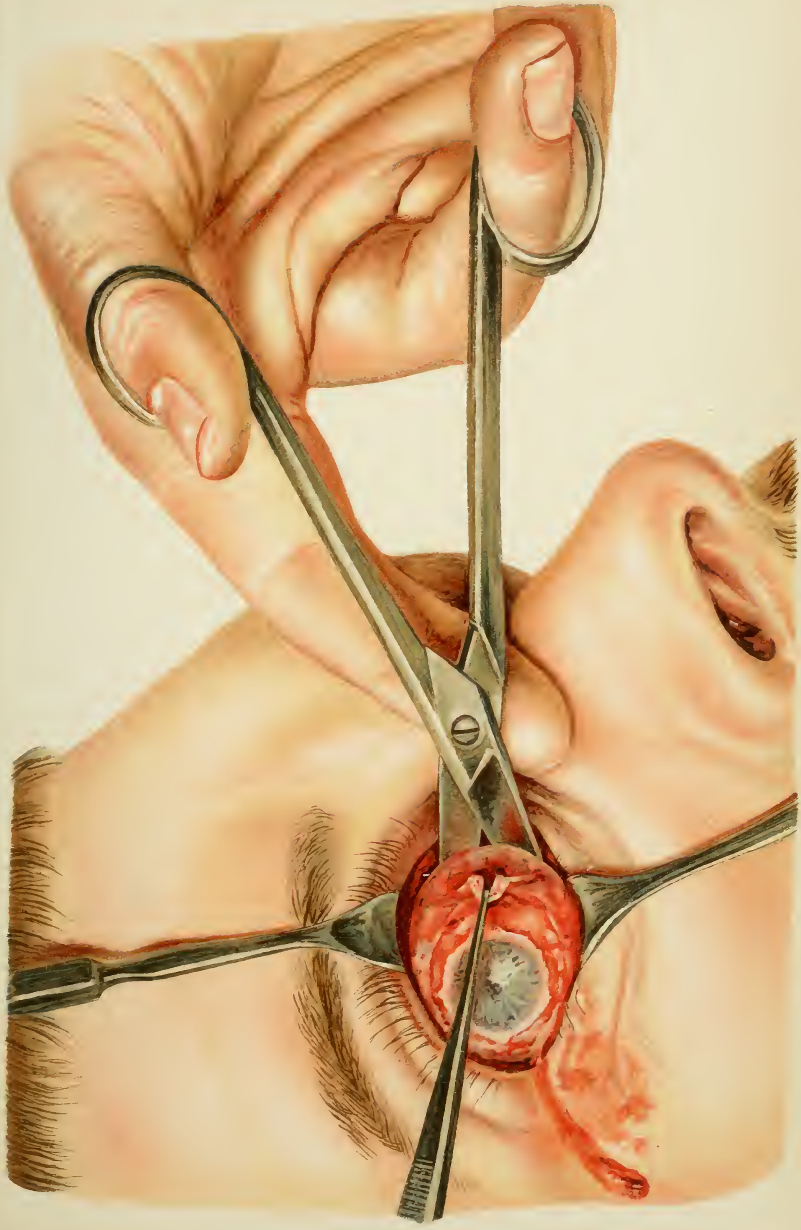
Enucleation of the eyeball. The globe has been rotated to the extreme right and the optic nerve is being divided with the scissors.

It is hardly necessary to say that the parts around the eye and the conjunctival sac must first be cleansed and the instruments boiled. It is not necessary to cut off the eyelashes or shave the eyebrow.

If the operation is performed under local anesthesia, a strabismus-hook for finding the muscle tendons should be used, the operator proceeding as follows: In enucleation of the right eye he takes up his position on the right side of the patient, who lies on the operating table; in case of a left enucleation he stands at the patient's head.

If the eye is enlarged from the presence of a staphyloma or buphthalmos, the external canthus is laid wide open with a pair of straight scissors (Fig. 108); the blunt blade of which is inserted under the outer commissure, which is then divided with one or two snips of the scissors.

With a pair of curved strabismus-scissors (Fig. 102) the operator then divides the cornea and, close to it, the conjunctiva, picking up the latter with a straight conjunctival forceps (Fig. 101) and slightly stretching it, so that it retracts; it is then divided and undermined. The undermining is then continued around the entire eyeball beyond the insertion of the muscles; when there are many old adhesions, this as well as the separation of the tendons is often a somewhat troublesome procedure. The four straight ocular muscles are then divided in the same way as in the operation for strabismus, each tendon being picked up with the hook. In this way the quadruple tenotomy can be performed without inflicting much damage and without giving pain by pulling and twisting the globe. It is best to begin with the external rectus, then, after the capsule has thus been opened, the superior is attacked with scissors and hook; next the inferior, and, finally, the internus, are separated from the globe, the latter being divided behind the hook—not between the hook and the



sclera—in order to leave a somewhat longer stump (3 to 4 mm.) by which to hold and abduct the eyeball. For the latter purpose the heavy fixation-forceps shown in Fig. 104 is used, and at this point of the operation the surgeon takes up the heavy, curved scissors (Fig. 105), the better and more surely to perform the last act of the operation. With the globe in extreme outward rotation, the surrounding tissues are carefully dissected away with the scissors, and the optic nerve is found by palpating carefully with the closed scissors. It is very important to see that the globe is accurately rotated outward—that is, brought into a position of simple abduction without either elevation or depression (Plate 9), and if this has been carefully attend to the optic nerve is found without any trouble. The operator then opens the scissors so that the nerve slips between the two blades, and cuts it off short at the globe with one snip. The eyeball at once advances, the two oblique muscles are divided, and the mass is gradually removed from the orbit.

In cases of enucleation for glioma of the retina as long a stump as possible is left in dividing the optic nerve—that is, the scissors are carried away from the globe and the optic nerve divided farther back.

When the operation is performed under general anesthesia, it is not so necessary to avoid pressure and traction on the globe, and Arlt's method may be recommended on account of its simplicity. When the globe is held fast by dense adhesions, however, the operation is somewhat more difficult; it is not to be recommended when the globe is soft. If the operator, as is usually the case, handles the scissors with the right hand, he should stand to the right of the patient. In enucleating the right eye he divides the optic nerve from the nasal side, as shown in Plate 9; and in the case of the left eye, from the temporal side. In the latter case the globe is, of course, rotated toward the nasal side. With a heavy, straight fixation-forceps (Fig. 104) the operator then seizes the conjunctiva near the corneal margin, in front of the internus, on the right

side, and in front of the abducens on the left; makes a vertical incision with the heavy straight scissors; prolongs the cut through the cornea, first downward and then upward along the cornea, as far as the opposite border; seizes the internus with the forceps in the same way as the tendon is seized in Arlt's method of tenotomy (in the case of the left eye the externus); and divides the tendon as in a strabismus operation, except that the division is made farther back, so as to leave a stump of tendon for the further manipulation of the globe. From this point the blunt blade of the same (straight) scissors, with the edge directed forward—that is, held flat and close to the sclera, is carried to a point behind the insertion of the inferior, where the tendon of that muscle is divided close to the bulb; after which the superior is divided in the same way. The globe is then rotated to the left side, and the oblique muscles, and finally the externus or internus, are divided with the same scissors, close to the globe. When, owing to great enlargement of the eye—especially posterior enlargement—or to a relatively deep position of a high nasal bridge, the optic nerve is not so accessible, a pair of curved scissors (Fig. 105) should be used. The same instrument should be selected in cases of glioma of the retina in which the optic nerve must be divided farther back than 1 to 2 mm. behind the sclera.

Landolt designed two kinds of scissors, curved both on the flat and over the edge, one to the right and one to the left, which can be readily introduced underneath the tendons. Landolt operates in the same way as Arlt, but always separates the externus first and then the inferior oblique, after which he always divides the optic nerve from the temporal side.

In arteriosclerotic individuals the hemorrhage during and after the operation may be quite severe, but it never requires ligation of the vessels. In most cases it is well, after thoroughly washing out the wound with cold bichlorid solution, 1 : 5000, to lay cotton plentifully on the cavity when the dressing is applied, for the purpose of

compression. If this fails to arrest the hemorrhage, the cavity must be packed with cotton, iodoform gauze, or even gauze saturated with adrenalin. Sometimes all that is necessary is to turn out the large clot that forms after the operation, after which the hemorrhage usually ceases.

Some operators terminate the procedure by closing the conjunctiva with a tobacco-pouch suture, or they may unite the upper edge of the bulbar conjunctiva with the lower, or attach each muscle individually to the conjunctiva, so as to get a more movable stump. I have had no personal experience with these different methods. I have always seen the cases end in normal recovery within six to seven days even without a tobacco-pouch suture, and only in very rare cases have I seen a mass of granulations result.

In fact, the tendency to healing in enucleation is very great, abnormal healing being quite rare. The patient is usually in a condition to be discharged in six or seven days.

Incising or puncturing the globe during the operation is an error in technic which must be specially guarded against. To avoid puncture one should dispense with sharp scissors. The accident of incising the globe, which usually occurs as the optic nerve is divided, is to be feared particularly in eyes that have become soft from cyclitis or injury, and have lost part of their contents. Hence it is well in such a case to fill up the eye before the operation by injecting cocain (see p. 15). Large traumatic wounds should, if possible, be allowed to close up partially before enucleation in order to increase the chances of successful operation, because pressure on the globe must be scrupulously avoided.

The result may be a failure if the operator, before dividing the optic nerve, fails to rotate the globe properly —that is, fails to keep it in the plane which passes through the internal rectus, external rectus, and the insertion of the optic nerve. The latter is thereby displaced either upward or downward, and the scissors, failing to find the

optic nerve, cut alongside and usually produce a large hemorrhage, which will make an inexperienced surgeon lose his head. Under such circumstances it is best to withdraw the scissors, let go of the globe altogether, then take a fresh hold and rotate it correctly, when the nerve may again be attacked with the scissors. The introduction of a retractor behind the globe, to displace it forward, sometimes proves dangerous, and is not to be recommended, because, although one is less likely to miss the optic nerve, it is thereby subjected to undue tension. Spoon-shaped instruments have also been constructed which are to be pushed behind the globe to facilitate the division of the optic nerve; but these instruments can be dispensed with.

If the outer commissure has not been divided, the globe may fail to emerge from the orbit even if the optic nerve has been properly cut, because the eyeball is too large or the palpebral fissure too small. In such a case the commissure must be split secondarily.

The indications for the operation are:

1. Malignant tumors.

2. Injuries in which enucleation becomes necessary, either primarily, on account of the great destruction of the globe; or, secondarily, because of failure to heal and the danger of sympathetic disease of the other eye. The latter is particularly apt to develop from retracted scars in the ciliary region (also postoperative scars), contracted globes with sensitiveness to pressure, and slowly progressing post-traumatic or postoperative cyclitis.

3. Uncontrollable pain in blind eyes, especially from glaucoma, either primary or secondary.

4. Staphylomatous degeneration of the eye.

5. Opinions differ in regard to panophthalmia and acute purulent inflammation of the interior of the eye, as death from meningitis was formerly observed after enucleating in cases of this kind. Many authorities to this day regard the presence of such inflammatory conditions as a contra-indication, although the number of those who consider the

operation justifiable is increasing. Personally, I have always regarded both mere intra-ocular suppuration and panophthalmia—that is, the extension of the inflammation to the tissues around the globe with protrusion, etc., as indications for enucleation, and have operated on a number of cases of that kind without any bad results.[1] Even in these cases recovery is usually smooth and remarkably prompt. The operation is a blessing to these unfortunate patients, because it not only shortens their sufferings, but to a great extent, also, their disability. The fact that I have observed uninterrupted recovery occur in many cases of the severest panophthalmia with protrusion, immobility of the globe, and marked edema of the palpebral conjunctiva is explained in part by the modern treatment of wounds; but it is, no doubt, due in part to the fact that microbes capable of producing inflammation (in these cases they were usually bacilli) had settled, or, at least, were demonstrated, only in a small portion of the interior of the eyeball, as has been proved by a number of microscopic examinations. The frightful inflammation to which they give rise and which spreads into the orbit was to be attributed solely to the spread of their toxins. Similar conditions may be present in many cases of this kind; and in this connection the observation made by Silberschmidt—that certain bacilli belonging to the group of the hay bacilli are responsible for some cases of panophthalmia—can only be demonstrated in the globe for a short time (they evidently die), although the inflammation does not subside at once.

As regards the antiseptic precautions necessary in these cases, one should, above all, guard against incising or puncturing the globe, and, if there is a large wound that has united, care must be exercised not to reopen it. Thorough flushing of the cavity, with a bichlorid solution of 1 : 1000, while the wound is held wide open with the lid specula is also indicated. In these cases a few disks

[1] Dr. C. Bauer has reported 53 cases from the years 1886 to 1900 (*Korrespondenzblatt f. Schweizer Aerzte*, 1901, p. 577.)

of iodoform and a little iodoform gauze should also be placed in the wound, and in cases of intense panophthalmia, drainage should be provided by means of a small rubber tube or a strip of iodoform gauze inserted between the lids and brought out at the outer or inner canthus. The lids are also to be covered with iodoform gauze, and the patient, in order to facilitate the escape of the secretions from the orbit, should lie on the side on which the drainage tube or gauze strip emerges.

It is needless to say that in all cases of purulent inflammation tobacco-pouch sutures and other kinds of sutures of the conjunctiva should be avoided. In my opinion these methods of suturing are in themselves bad surgery and, except in wounds in which the asepsis is perfect, unjustifiable.

[It is evident that suppuration within the globe should not be permitted to continue without interference, and the surgeon must decide between enucleation and evisceration. Although the risk of meningitis or of a fatal termination from any cause after enucleation for any pathologic process within the globe is exceedingly rare—being about 1 in 1600 operations—it must be remembered that in the majority of cases the lethal issue has occurred when the pathologic condition of the eyeball at the time of the enucleation was one of partial or complete suppuration. Now, while it was not always possible to connect the meningitis directly with the operation, in some instances this connection was definitely established; hence the claims of evisceration must be considered. See a paper by the editor on "The Comparative Value of Enucleation and the Operations which have been Substituted for it.—XIII. International Congress of Medicine, Paris, 1900. Section on Ophthalmology.—Ed.]

Other operations have been suggested in the place of enucleation, the latter leaving a bad deformity.

1. **Resection of the optic nerve** (*Neurectomia Opticociliaris*) was suggested by Schweigger, to take the place of simple division of the optic nerve, which had been used before his time. He recommended

and adopted the following procedure: An incision is made in the conjunctiva and Tenon's capsule, 3 mm. behind the insertion of the right internus; the muscle is exposed, and a blunt strabismus-hook (not guarded) curved on the flat, and then another, are introduced underneath the muscle. As the two hooks are drawn in opposite directions, one of them catches on the angle at the insertion and rotates the eye outward, while the other draws the muscle up out of the orbit. Underneath the second hook a needle, threaded with catgut, is passed through muscle and conjunctiva, reinserted close to the point of exit, and brought back again through conjunctiva and muscle. The muscle is then divided 5 mm. behind the insertion, and the suture is tied. A second similar suture is introduced through the tendon and conjunctiva and tied at the anterior extremity of the muscle. The wound is then enlarged in the direction of the superior and inferior recti, a small, sharp double hook (Fig. 72) is inserted into the sclera as far back as possible, and the eye is drawn forward and outward. A pair of flat scissors are then introduced along the globe until the orbit is reached, the optic nerve is sought for and divided as near as possible to the optic foramen. With the aid of the double hook the posterior portion of the periphery of the eye is rolled forward, and the tendon stump adherent to the globe is cut off close to the scleral insertion; finally the eye is replaced and the wound is closed with the sutures that have been introduced at the beginning of the operation. As a last step the palpebral margin is also closed with a few silk sutures. Three sutures are quite enough to control the bleeding and exophthalmos; but if this precaution is neglected the hemorrhage may prove most unpleasant. After about four days this danger is obviated and the sutures, which by that time have usually cut through the skin of the upper and the lower lid, are removed.

de Wecker simplifies the operation of resection by confining it to the optic nerve, from which he excises merely a section from 5 to 6 mm. in length. He also devised a hook for seizing the optic nerve, and a pair of scissors with which the nerve can be compressed after it has been divided; in that way he claims to diminish the hemorrhage.

Resection, which I have, so far, never performed myself, may be suitable for isolated cases in which one has to contend with severe pain accompanied by blindness, as, for example, in glaucomatous degeneration. But the method is not a sure preventive of sympathetic ophthalmia, for the disease has been known to occur even after resection had been performed.

2. **Exenteration** or **evisceration** of the globe is another operation that has been recommended as a substitute for enucleation, and is quite frequently performed. The object is to remove the entire contents of the globe through a circular incision in the sclera behind the cornea, after which the sclera is closed in front. It is claimed that in this way a larger and more movable stump is obtained, affording a better hold and greater mobility for the artificial eye. Alfr. Gräfe and Bunge proceed as follows:

After thoroughly disinfecting the operative field, the sclera is divided by a circular incision immediately behind the cornea, the operator seizing the palpebral conjunctiva close to the corneal margin to his right

side with conjunctival forceps, while his assistant at the same time grasps the conjunctiva at a point 5 mm. farther back, but in the same meridian. Between the two forceps, close to the anterior forceps, the sclera is then carefully incised, layer by layer, with a broad scalpel, until the dark ciliary body appears in the wound. With straight scissors, the blades of which are not too thick, and must be blunt at the points (Stevens' scissors shown in Fig. 92 are suitable), the incision is then enlarged, while the sclera is held fast with the two forceps, one blade of the scissors being pushed forward between the ciliary body and the sclera. After each snip of the scissors the two forceps take a new hold on the sclera where the incision ends. After the incision has thus been enlarged around the upper half of the cornea, the same thing is done around the lower half, keeping constantly close to the corneal margin. By means of Bunge's scoop the entire contents of the globe is then removed, if possible *in toto*, and if not, piece by piece. After the cavity of the scleral cut has been thoroughly cleansed by scraping with scissors and forceps, or rubbing with gauze, and has been washed out with a disinfectant, the opening in the scleral cavity is brought together with 3 to 5 sutures, which include the conjunctiva, the wound being then closed in a horizontal direction; or a tobacco-pouch suture may be introduced.

The after-treatment in this operation is much more distressing to the patient than in the case of enucleation.

The other eye should also be bandaged for from two to four days. Severe ciliary pain often develops and has to be relieved with morphin. The sutures are removed on the fifth day. In from eight to ten days, if everything goes well, recovery is complete. Possible complications are orbital cellulitis, intense unilateral headache, and slight febrile movements. Occasionally the operation needs to be followed by a secondary enucleation. If the scleral cavity fills with blood and granulation grow in it afterward, the resulting stump may be primarily quite small, not much larger than after enucleation. Sometimes the stump becomes small secondarily because shrinking continues for months and even years, so that the result is not worth the trouble and distress to the patient.

This consideration suggested the attempt to cause a spherical body of glass (Mules), celluloid (Lang), silver (Kuhnt), etc. [gold-plated balls are very satisfactory—Ed.], to heal into the scleral capsule. The same thing was done by Frost and Lang after enucleation, with the object of getting the foundation for the artificial eye to heal into Tenon's capsule. Unfortunately, these balls of glass and other materials are usually extruded after a time.

Exenteration is not a suitable procedure in cases of malignant tumor, because one can never be sure that the inside of the sclera has not been attacked. In cases of purulent inflammation, also, I do not believe that the procedure is sufficiently radical to insure perfect removal of all the elements that are responsible for the inflammation. In fact, I consider that this operation is bad surgery, because it leaves a cavity with rigid walls, with a possibility of noxious material being retained in it. Robust as the sclera is, it nevertheless consists of living tissue, and it has been shown by microscopic investigations (S. Ruge) that it is very difficult

to render the inside of the scleral cup absolutely free from cells or microbes. It is, therefore, doubtful whether exenteration affords sufficient protection against sympathetic disease.

[Professor Haab's statement that the artificial vitreous (glass or gold globes) used in Mules' operation "are usually extruded after a time" would not seem to be entirely substantiated by statistical information. In 1900, before the Thirteenth International Congress of Ophthalmology, the editor read a paper in which 317 operations of this character were analyzed, and in only 17 per cent. was there escape of the artificial vitreous. In more carefully performed series of similar operations this percentage is reduced to 8. The operation should be performed as follows:

After general anesthesia a stop speculum is introduced, and the conjunctiva dissected from the corneoscleral attachment, in all directions to the equator of the ball, without disturbing the muscles. The cornea and 1 mm. of the scleral margin are removed in the manner described under Evisceration. Next, the contents of the globe are emptied by any convenient method, a small evisceration scoop being a satisfactory instrument. Great care must be taken to remove the entire contents, leaving a perfectly clean, white sclera. Hemorrhage is controlled by packing the scleral cavity with sterilized gauze, and by frequently irrigating it with a tepid solution of bichlorid of mercury, 1 : 5000. A glass or gold sphere of such size that it may be introduced within the scleral cup without difficulty is selected, its introduction being facilitated by splitting the sclera vertically for about 4 mm. at the upper and lower margins of the opening. The introduction of the glass sphere is further facilitated by the use of an instrument specially devised by Mules for this purpose. The concluding steps of the operation consist in stitching the sclera vertically, the conjunctiva horizontally, and applying a full antiseptic dressing. The greatest care should be exercised to secure absolute asepsis during the operation and at the subsequent dressings. The patient should

be confined to bed for at least four or five days. Considerable reaction and marked chemosis of the conjunctiva may follow. This may be controlled by the continuous application of cold, and probably be avoided by not removing the bandage for forty-eight or even seventy-two hours. Mules recommends that the sutures should be of catgut; the editor prefers silk sutures.

Implantation of an artificial globe in Tenon's capsule after removal of the eyeball is performed as follows:

The eyeball is enucleated in the ordinary manner, and, after all bleeding has been checked, a gold or glass sphere is inserted within Tenon's capsule. The capsule and conjunctiva are next sutured over the artificial globe with silk, the tendons of the ocular muscles having previously been secured by one of the methods described under Enucleation. The subsequent treatment is the same as that suited to Mules' operation.—Ed.]

Artificial Glass Eyes.

The improvement in artificial eyes, which was stimulated a few years ago by Snellen, has greatly diminished the importance of the two operations that are performed instead of enucleation, and they are therefore even less justifiable than they were formerly. The artificial eye which had been used until that time consisted of a comparatively thin glass shell, and was originally intended only to be worn over a more or less phthisical globe. Snellen then induced the firm of Müller Söhne, in Wiesbaden, to manufacture eyes consisting of a double shell, which possess the advantage that they fill out the orbital cavity more completely and have smoother edges. After much trouble the firm succeeded in turning out artificial eyes of the proper form and workmanship, which they call "reform-eyes." One of the great advantages is that they prevent the collapse of the upper lid, which occurs when the old form of artificial eyes is worn, and spoils the expression. Snellen is quite right in saying that it is more important that an artificial eye should fill the orbital

cavity completely than that it should have a wide range of movement. A great many people hardly rotate their eyes at all and get along by moving the head. In any case it is better to advise the patient who is forced to wear an artificial eye to move his head instead of his eyes. The following rules should be observed: It should be impressed upon the patient to get a new glass eye at intervals of eighteen months to two years, because the glass becomes rough and may produce irritation and a discharge of mucus, followed by cicatrization and shrinking of the cavity, which ultimately contracts to such a degree that it becomes difficult or even impossible to wear the artificial eye. This is particularly apt to happen with the old style with narrow edges. Abrasion and cicatrization may also occur if one has made the mistake of wearing one too large in order to make sure of completely filling the cavity. One should never order an artificial eye so large that the lids can not completely close over it.

In the case of phthisis of the eyeball, the patient should not be allowed to use an artificial eye unless it is perfectly comfortable.

A glass eye should be removed at night in order to prevent it from getting rough. It should not be placed in water, but merely cleansed and then laid away dry. The patients soon learn how to insert it: first under the upper, and then under the lower lid. Removal is best accomplished by means of a glass-headed pin; this is inserted under the lower edge of the artificial eye, which is then drawn forward.

OPERATIONS ON THE ORBIT.

Opening an abscess in the anterior portion of the orbit is a comparatively simple operation, as the abscess usually starts in the bone or the periosteum of the orbit or in the adjoining bony cavities. A broad incision is made as close to the bone as possible, taking care, above all, not to injure the levator palpebræ superioris.

When the pus is in a deeper situation, as when it has its origin in one of the accessory sinuses of the orbit, particularly the ethmoidal and sphenoidal cells, a so-called orbital phlegmon often results. This is a dangerous and often a violent inflammatory process, which not only soon destroys the optic nerve and the patient's eyesight, but may also threaten his life. Immediate operative relief is imperative. Free drainage must be provided for the inflammatory products (edema, pus, etc.) contained in the orbit, in order to rescue the tissues from compression and intoxication. For this purpose a large incision is made at that portion of the orbital margin opposite which the greatest degree of inflammation and swelling is discovered in the depths of the tissues—that is, for example, above and to the nasal side when the protruding globe is displaced downward into the temporal side.

The patient is anesthetized and a curved incision, 4 to 5 cm. in length, is made directly over the orbital edge, dividing the periosteum. The latter is then separated from the bone with an elevator (Fig. 112) to a depth of 3 to 4 cm. By keeping between the bone and the periosteum all danger of wounding the levator, the trochlear nerve, or the lacrimal gland is avoided. Separation of the periosteum is often followed by a flow of pus from below, or, if not, the wound is held open with hooks and the periosteum is incised in the depths of the orbit when pus is suspected. By cutting from behind forward it is not difficult to avoid the eye muscles. Even if no pus is found, but only inflammatory edema, the incision does good and is absolutely required to preserve the integrity of the optic nerve. Afterward iodoform gauze or a drainage tube is introduced as far as possible into the wound to facilitate the escape of the secretions. At the same time, the diseased accessory cavity which contains the source of the process must be subjected to vigorous treatment.

THE REMOVAL OF TUMORS FROM THE ORBIT.

Tumors in the anterior portion of the orbit can usually be removed without much difficulty by a curved incision running parallel to the orbital margin, or they may be peeled out or dissected out by going in through the conjunctiva. Among such are cysts, which are fairly common (see *Atlas of External Diseases of the Eye*, Pl. 12, Fig. *c*). The operator must be careful to remove every portion of the cyst, and this is not always an easy matter, because they may extend far into the depths of the tissue. It will be easier to remove the posterior portion without injuring the globe and without leaving anything behind if the cyst is first incised at some convenient point on the anterior wall, and part of the contents evacuated; the small incision must, however, be closed with a ligature, so that the posterior wall may still retain some of its rigidity.

Non-encapsulated angiomata in the anterior portion of the orbit and often extending into the lids are usually congenital and of slow growth. These tumors, according to Knapp, may be best extirpated by inserting the horn handle of an ordinary lid speculum (Fig. 17) into the conjunctival sac underneath the lid in order to avoid a profuse hemorrhage into the operative field. The instrument is pushed back under the tumor as far as the wall of the orbit, and the flow of blood to the angioma is thus controlled by pressure. The tumor is turned out through the skin, avoiding the levator palpebrarum if the tumor occupies the upper lid. Small remnants that have extended to the skin of the lids or as far as the palpebral margin, or even to the back of the posterior surface of the lid, may be left behind; according to Knapp, they disappear after the main tumor has been removed.

For the removal of small palpebral angiomata the lid-clamps designed by Knapp, Desmarres or Snellen (Figs. 120, 122, 124) are extremely useful. With this instrument the operation practically becomes bloodless.

Retrobulbar angiomata and cavernomata are extirpated

FIGS. 106-112.—Instruments for Krönlein's operation (half-size):
FIG. 106.—Scalpel.
FIG. 107.—Stout curved scissors, after Cooper.
FIG. 108.—Heavy straight scissors with protected points.
FIG. 109.—Forceps.
FIGS. 110, 111.—Tenacula.
FIG. 112.—Elevator.

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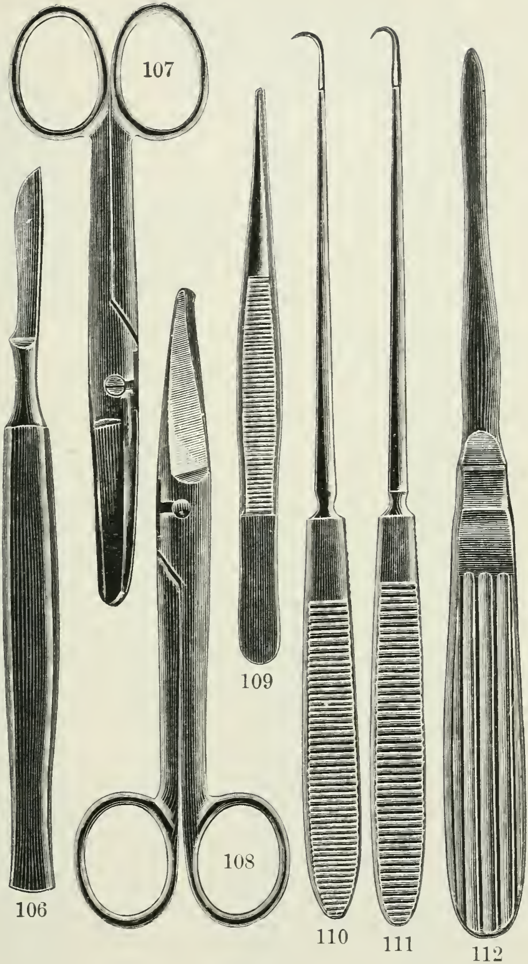
in the same way as other retrobulbar tumors; the method will be discussed later.

Whenever the whole or the greater part of a tumor spreads out behind the globe, a more radical operation is required for its removal. Up to the time when Knapp (1874), and especially Krönlein (1889), described their methods of operation, retrobulbar tumors, with few exceptions, were treated by enucleation of the globe.

If the globe has been displaced far forward by a tumor situated at the back of the orbit and frequently beginning in the optic nerve, especially a myxosarcoma or fibrosarcoma, it may be possible, on account of the anterior displacement, to remove it from in front without sacrificing the globe, after Knapp's method; but the limited amount of room and the inaccessibility of the tumor are distinct disadvantages which increase with the size of the tumor and the number of adhesions to the surrounding tissue. Krönlein's operation permits much easier access to the operative field.

In Knapp and Lagrange's operation for the removal of retrobulbar tumors without sacrificing the globe, a method which is best adapted for the optic nerve, access is gained to the retrobulbar space through a large conjunctival incision, either from the nasal or from the temporal side, depending on the position of the tumor. If necessary the externus or internus, and sometimes a second muscle, is divided after having been secured with a suture, which is afterward used to unite the two divided ends. By this method the globe can be drawn farther to one side, and better access is obtained to the deeper portions, so that the tissues can be dissected out with the finger or the hollow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FIGS. 113–116.—Instruments for Krönlein's operation (half-size):
FIG. 113.—Spatula for keeping back orbital congestion.
FIG. 114.—Chisel.
FIG. 115.—Mallet.
FIG. 116.—Electric circular saw.

probe until the tumor is reached. At this point a ligature may be passed around the posterior portion of the optic nerve with an aneurism-needle and the structure tied off; the nerve is then divided as close as possible to the optic foramen, and the tumor turned out after the globe has been turned completely around. Next the optic nerve is cut off close to the globe; the latter is replaced; and the muscles and conjunctiva are reunited by sutures. If profuse hemorrhage from the deeper tissues takes place, an attempt may be made to control the exophthalmos by closing the palpebral fissure.

It is evident that under certain circumstances it may be difficult with this method to remove all the posterior portion of a tumor and leave a clean surface. Fortunately, primary tumors of the optic nerve are often benign myxosarcomata, which represent the majority of all optic-nerve tumors; and, although the posterior portion of such a tumor may remain in the optic canal, it will not proliferate (Salzmann). In the case of sarcoma and endothelioma complete extirpation is unavoidable.

Krönlein's Operation.

This represents a distinct advance in orbital surgery. It possesses the immense advantage that the operative field, the retrobulbar space, is much more freely exposed, so that the surgeon can see what he is doing, and is therefore able to operate without doing so much harm. The instruments which my colleague, Krönlein, uses for this operation and which I obtained from him for the artist's use (and I wish to mention here that I am also indebted to his kindly help for the authentic illustrations on Plates 10 and 11 as well

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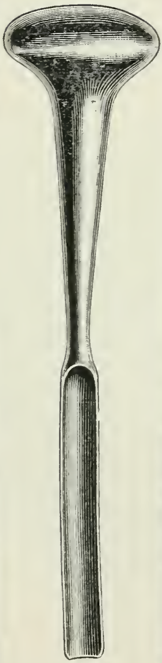

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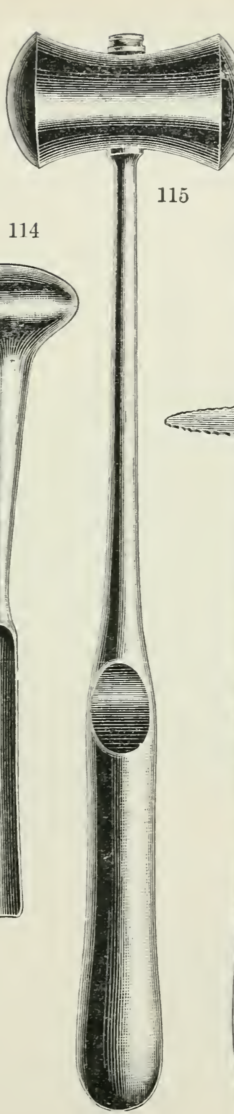

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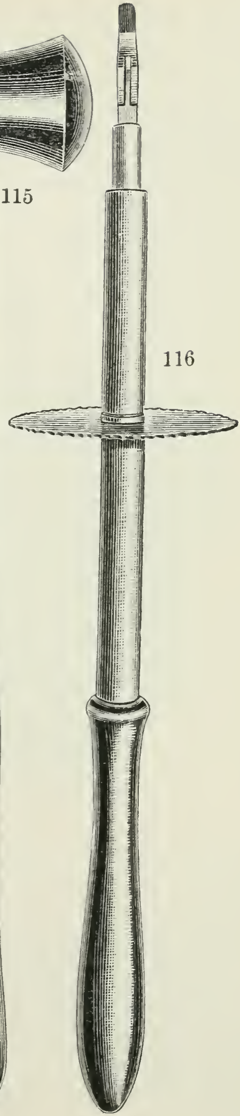

Plate 10.

Opening of the orbit after Krönlein. The skin-muscle-bone flap has been reflected forward and shows a large portion of the periorbita. The latter is then incised from behind forward, producing the picture shown on the next Plate.

as for Fig. 117), are illustrated in Figs. 106–116. Axenfeld has devised for this operation special blunt hooks and holders or retractors, in the form of round plates attached to an angulated handle, for holding the orbital tissues apart. (This may be obtained from Windler, in Berlin.)

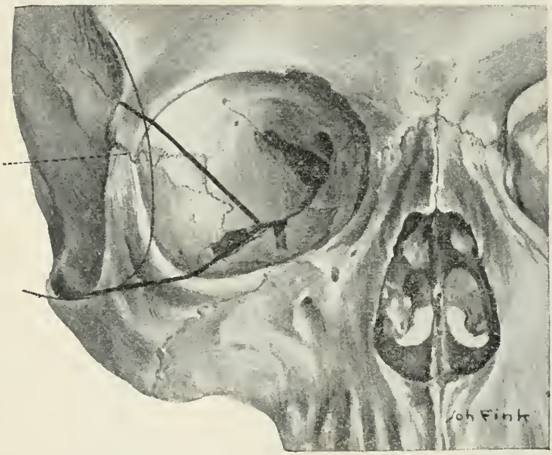

FIG. 117.—Skin incision (curved line) and bone incisions (heavy lines) in Krönlein's operation.

Independently of Wagner, who suggested in 1886 that it might be advisable under certain circumstances, especially for the removal of foreign bodies, to make a temporary resection of a wedge-shaped piece of the orbital edge, Krönlein, in the same year, performed his first operation of this kind, after he had tried it on a cadaver and had developed a definite plan of operation.

Technic.—The operation is performed under anesthesia. The eyebrows and hair having been shaved from the entire temporal region, an assistant rotates the patient's head slightly toward the sound side, and the operator takes his position at the patient's head or to one side, under lateral illumination. The first step of the operation consists in dividing the soft parts with a curved incision, as shown in Fig. 117. The incision begins above, at the point where the linea semicircularis of the frontal bone, which is readily felt, intersects a horizontal line running 1 cm. above and parallel to the supra-orbital margin, and is carried downward in a gentle curve along the temporal edge of the orbit to the level of the upper edge of the zygoma, where it makes a bend backward and ends at the center of the zygoma. The center of the curved incision bisects a horizontal line which connects the outer canthus with the outer orbital margin. In this intermediate portion the incision should be carried down to the opening, while at the upper and lower portions of the orbit the knife should divide only the skin, fascia, and muscular layer. The length of this incision in adults should be from 6 to 7 cm., and in children two to seven years old about 4 cm. It is important not to make the incision too small and to make it exactly as described above. Above all it should not be near the temporal side, but slightly to the nasal side of the temporal margin, in order that the latter may remain well covered by its soft parts.

At the central portion of the skin incision, where it is carried down to the bone, a sharply bent elevator (Fig. 112) is introduced, and the periorbita is separated as a whole from the external orbital wall upward to a point about 1 cm. above the zygomatico-frontal suture, downward to the anterior orbital fissure, while the depth should carry it well behind the zygomatico-sphenoidal suture. The point of the elevator is then carried vertically downward as far as the anterior orbital fissure, in order to determine the point where the open incisions presently to be made are to converge. The elevator should not be

Plate 11.

Opening the orbit after Krönlein. After the periorbita has been divided, the deeper tissues are dissected out so as to bring the posterior portion of the globe and the optic nerve clearly into view. The large wedge of bone that has been chiselled out is also distinctly recognizable from its orbital side as far as its apex.

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introduced into the fissure with too much force, so as not to injure the infra-orbital nerve.

The bone incisions (see Fig. 117), which are now in order, must mobilize the piece of bone which is to be temporarily removed, consisting of a wedge, the base of which is formed by the outer orbital margin, zygomatic processes, frontal bone, and frontal processes of the zygoma, while the apex lies behind the anterior extremity of the anterior orbital fissure. The soft parts having been pushed to one side, and the periosteum divided down to the bone in the line of the bone incision, the zygomatic process of the frontal bone is cut through transversely with the chisel above the zygomatico-frontal suture, which is readily felt, or with an electric circular saw (Fig. 116). This bone incision must not be placed too high, to avoid opening the cranial cavity. Beginning at this horizontal upper incision the bone is divided with a sharp chisel (in order not to splinter the bone) in a straight line running obliquely through the lateral wall of the orbit to the elevator, which is fixed in the anterior orbital fissure—*i. e.*, to a point 1 cm. behind the anterior extremity of the fissure; at the same time the orbital contents are gently pressed toward the nasal side with the elevator. The next step consists in a horizontal division with a chisel or a saw of the frontal process of the zygoma, close to its base; this is also continued into the fissure. The piece of bone is now movable and may be reflected outward along with the skin-fascia-muscle flap of the temporal region far enough to give free access to the orbit, which is still half-covered by the periorbita (Plate 10). The latter must be split from before backward with the blunt scis-

sors (Fig. 108), and held apart with tenacula applied above and below (Plate 11), whereby free access to the retrobulbar space is obtained. Superficially lies the right external rectus muscle, which, if necessary, is divided near its tendinous insertion, after sutures have been introduced, so as to make it possible to unite the divided ends. Or the abducens may be merely drawn to one side, and the dissection continued along the optic nerve with Cooper's scissors (Fig. 107). As the wound gradually becomes quite deep, good illumination is absolutely necessary, especially when the operator has to advance to the apex of the orbital funnel or as far as the nasal portion of the orbit. During the operation the globe may be pushed slightly forward and inward with a blunt hook, and the orbital fat pushed aside with the instruments shown in Fig. 113, or with Axenfeld's plates.

After the retrobulbar operation has been completed, the eye muscles that have been divided are reunited; the skin-muscle-bone flap replaced; the periosteum secured with a few silk sutures; and, finally, the soft parts are carefully sutured with silk. A drainage tube or iodoform wick is placed in the upper portion of the wound, but can, as a rule, soon be removed. An aseptic and occlusive bandage, covering the entire eye, is applied. The globe should be carefully covered by the lids, especially in cases in which the cornea is anesthetic, so that if there is no ptosis it may sometimes be advisable to close the palpebral fissure with sutures (Axenfeld), a procedure which is also valuable for controlling a postoperative retrobulbar hemorrhage (Braunschweig, Ellinger).

As in many cases this method has been found to possess the disadvantage of leaving the eyeball with defective power of abduction, it is important in this operation to avoid injuring the abducens, not only when the periosteum is opened, but also later on; in fact, during the entire operation the tissues should be dissected away with much caution, to avoid injuring the nerves and the rest of the orbital tissues.

There is no special advantage in making the bone incisions with a Gigli wire saw from within outward or from behind forward (Schuchardt, Torek). My colleague, Krönlein, was kind enough to tell me that he gave up this method because the introduction of the wire is not by any means such a simple operation, especially if, as Torek advises, the outer orbital wall is first perforated for the upper oblique incision.

Czermak, after experimenting on cadavers, proposed a modification of Krönlein's operation, having for its object to obtain still better access to the orbit. He resected with a chain saw not only the outer, but also a small portion of the lower, wall of the orbit. Domela-Nieuwenhuis, in his exhaustive monograph on Krönlein's operation, offers a criticism of this procedure, based on careful tests performed by himself, and concludes that Czermak's operation is so complicated as to belong rather to the province of the surgeon, while Krönlein's operation can easily be performed by an oculist. Besides, he says, Czermak's operation, although much more difficult, affords but little better access to the orbital cavity than is obtained by means of Krönlein's operation; and finally it is to be remembered that the latter usually gives room enough if it is properly carried out.

Another modification of Krönlein's operation was proposed by Parinaud and Roche. In order to avoid a scar near the outer canthus of the eye, with the possibility of distortion in that direction, they made the base of the skin-flap at the orbital edge and reflected it forward. From the temporal portion of the eyebrow a horizontal incision is carried 5 cm. backward, then 5 cm. upward, and finally 5 cm. forward, making a four-cornered flap which is reflected forward. The rest of the operation is the same as Krönlein's. Although the case reported by the authors made a good recovery, the nutrition of the bone is in much greater danger in this operation than in Krönlein's,[1] since it is attached only by the temporal fascia and temporal muscle.

Under the name of malar orbitotomy Rollet recommended temporal incision of the body of the zygoma and performed it in a case of exophthalmos. He exposed the bone by a curved incision along the outer and lower edge of the orbit, to which he joined short incisions at the upper and lower extremity, forming right angles with the first incisions; chiselled through the frontal process, the temporal process of the zygoma, and the insertion of the latter in the upper jaw, after which he bent the zygoma outward and downward with the finger. Later the bone is raised and returned to its original position.[2]

Entering the orbit from above, as proposed by Cahen and Franke, is a much more difficult and complicated undertaking. Cahen, in an operation for the total extirpation of the supra-orbital nerve, chiselled away the entire orbital wall for good, after he had gained access by

[1] These authors evidently misunderstood Krönlein's method, for they speak of a vertical skin incision 6 to 7 cm. in length, which, they imply, was improved upon by Jonnesco's adding horizontal incisions.

[2] Rollet also is not sufficiently acquainted with Krönlein's procedure; as appears from his criticism that it involves fracture of the outer orbital wall, which might extend into the sphenoidal bone.

temporary resection of a piece of the frontal bone and pushed the dura mater aside with the bone. Cahen believes this method to be suitable for regular orbital operations. Franke, after experiments on cadavers, proposed to expose the upper portion of the orbit by temporarily resecting the upper edge of the cavity and reflecting it downward along with the skin. In this way, he says, it is possible to reach the optic foramen.

The two methods devised by Gussenbauer, and consisting in temporary resection of the framework of the nose, to expose the two orbital cavities, and the frontal, ethmoidal and sphenoidal sinuses, sometimes on both sides of the head, may be tried in orbital cases with simultaneous diseases of the ethmoidal and sphenoidal cavities, especially in the presence of bilateral retrobulbar disease.

The operations of the three latter-named authors are very much more complicated than that of Krönlein, and in my opinion belong to the province of the general surgeon.

It appears from Domela's comprehensive collection of cases, and other contributions to the literature that have appeared since then, that the indications for Krönlein's operation are: 1. Cyst, particularly retrobulbar cyst, including echinococci and cysticerci (the latter are rarely found in the orbit). 2. Tumors of the optic nerve and of its sheath. 3. Retrobulbar cavernous angioma, lymphangioma, and other retrobulbar tumors, also aneurisms, and varicose dilations of the orbital veins. 4. Retrobulbar injuries, particularly foreign bodies in the orbit. 5. Orbital abscesses (phlegmon). 6. Any operations on the deeper portions of the eyes (removal of a subretinal cysticercus in the macular region, opening the sheath of the optic nerve in choked disk, Müller's operation for retinal detachment, etc.). 7. Finally the operation is also perfectly justifiable for purposes of diagnosis in doubtful cases (Franke, Braunschweig), because it is absolutely free from danger, and is often the only means of arriving at an accurate diagnosis of a retrobulbar process.

Exenteration of the Orbit.

The object in evacuation of the orbital cavity is to remove not only the globe, but all the remaining contents of the orbit, as completely as possible. It is usually necessitated by malignant tumors, be it that a neoplasm

has advanced from the interior of the globe into the orbit, or that the latter is the primary site of the sarcoma, etc. Exenteration may sometimes have to be performed after enucleation if, after the globe has been removed, it is found to be ruptured and permits portions of the tumor (sarcoma or glioma) to escape; the perforation may be quite small.

This operation also requires a general anesthetic. The first step consists in dividing the outer angle of the lid in a line coinciding with the prolongation of the palpebral fissure, with heavy straight scissors (Fig. 108), carrying the incision a good centimeter beyond the edge of the orbit. Beginning at the outer orbital edge, which has thus been exposed, an incision is made through the soft parts around the orbital cavity from the conjunctival sac to the bone, the lids being held well apart with retractors. This incision is made with the scalpel (Fig. 106), which must be kept close to the orbital margin. As this incision at the same time divides the periosteum along the edge of the cavity, it is usually easy by means of the elevator (Fig. 112), which is introduced at the outer angle between the orbital margin and the periosteum, to separate the periosteum from the bone in every portion of the orbit, passing carefully over the thin parts of the bone, particularly the inner orbital wall (lamina papyracea of the ethmoidal bone, and lacrimal bone), so as not to perforate the bone. Wherever the elevator meets with greater resistance the tissues are divided with the scissors. The attachment of the posterior limb of the inner palpebral ligament and the capsular tag of the internal rectus, particularly, will have to be divided with the scissors.

After the periorbita has thus been removed from the entire orbital funnel as far as the apex, so that the wedge-shaped contents of the cavity are held merely by the pedicle formed by the optic and remaining nerves, the blood-vessels, the insertions of the muscles, and the periosteum, these tissues are divided with large Cooper scissors (Fig. 105), which are introduced along the outer

orbital wall. In this way the entire contents, surrounded on all sides by periosteum, can be removed. The hemorrhage from the large orbital vessels which follows can, as a rule, be controlled by packing with iodoform gauze; if it is very profuse the place may be cauterized with a Paquelin cautery. The cavity should be packed with a long strip of iodoform, which can afterward be removed gradually, a piece at a time. In any case the iodoform gauze must project in front between the lids, which are not closed, and must communicate with the gauze in the dressing, so as to enable the secretions to escape from the cavity. Czermak suggests that the entire orbital cavity be filled with a large round piece of iodoform gauze, to the center of which a ligature has been attached; this is stuffed into the cavity like a pocket and filled with strips of iodoform gauze, some of the latter remaining between the lids, which are held open. In the cavity the gauze should not be packed too tightly. When the dressing is changed the contents of the pocket are removed before the latter is withdrawn by means of the suture attached to its center.

Since, after exenteration of the orbit, the lids retract into the orbit as healing takes place, it is impossible to wear a false eye after this operation. It is therefore necessary to do something to correct the ugly deformity which would be produced by an empty orbital cavity. The indication for this is particularly strong when one or the other of the lids, or both, have been removed at the operation because they are involved in the neoplasm.

Another reason for covering the large wound in the case assumed is that the period of healing is greatly shortened by such a procedure. If both lids have been removed at the operation, or if, as in the case shown in Plate 12, they have been destroyed by the neoplasm (carcinoma), the procedure which was customary in von Langenbeck's clinic (Krönlein, namely, covering the defect with a large skin flap obtained from the neighborhood, as, for example, the forehead, will give the best results. The skin flap

Plate 12.

Destruction of the orbit by carcinoma (rodent ulcer). Destruction of the lids and globe, leaving only a small, roundish, shrunken remainder in the large cavity, the deepest portion of which communicates with the ethmoidal cells (dark spot in the picture), and laterally with the nasal cavity. It is probable that the carcinoma started in the lids. The result, after extirpation of the neoplasm, which was performed by my colleague, Krönlein, is seen in Figure 118 (p. 296).

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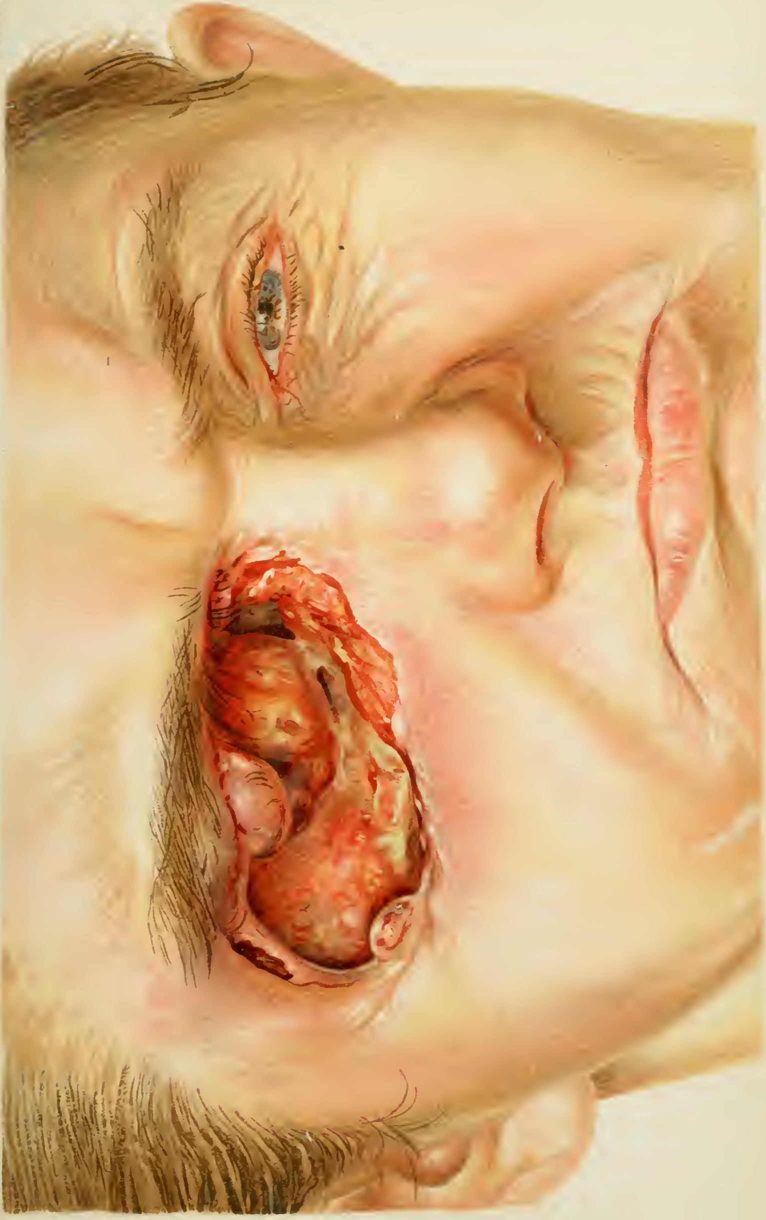
required for occluding the exenterated orbit must have a pedicle, and may be obtained, depending on the necessities of the individual case, either from the skin of the cheek, as in the two cases cited by Krönlein, or from the skin over the temporal and frontal regions. (Information kindly imparted to me by my colleague, Krönlein.) Küster also recommended covering the wound. The operation may be performed as shown in Figure 118, which represents a picture of the woman, taken eight weeks after the operation by my colleague, Krönlein, for a carcinoma which had penetrated far into the orbit, as shown in Plate 12. The entire cavity of the wound was closed with a large flap taken from the forehead, the edges of the flap being carefully united to the edges of the large wound with sutures; after which the denuded area in the forehead was at once covered with skin grafts, after the Thiersch method. Both the latter, as well as the large pedunculated flap, healed perfectly, nor was there much retraction later, because the orbit became filled with a thick, fibrous tissue, formed by proliferating granulations.

When exenteration of the orbit is performed without sacrificing the lids, Küster's suggestion may be adopted, and more rapid healing induced by freshening up the edges of the lids and uniting them with sutures. The follicles of the lashes and the entire conjunctiva are removed, and the palpebral fissure is closed with sutures, all but one-quarter for the escape of the iodoform tampon with which the cavity is filled, and which, after a few days, can be replaced by a short drainage tube. A light-pressure bandage is then applied, and if no infection takes



place, complete healing occurs within one to two weeks, although the united lids become somewhat retracted, but only form a shallow depression. If one eyelid has been sacrificed, the remaining one is utilized in the manner described above to cover the cavity with a skin flap.

It has also been advised to line the entire cavity with skin grafts, after the Thiersch method, after exenteration of the orbit without sacrificing the lids.

C. OPERATIONS ON THE LIDS AND IN THE CONJUNCTIVAL SAC.

I. OPERATION FOR PTOSIS.

Ptosis may be congenital (usually bilateral) or acquired, and in the latter case it may be unilateral or bilateral, from paralysis of the nerves (oculomotor or sympathetic), or from muscular anomalies from disease or after an injury.

The operative procedures vary according to the cause and character of the ptosis. If, as is often the case in the congenital form, the levator is practically inactive or entirely absent, either functionally or structurally, an effort must be made to secure elevation of the lid through other muscles, either of the occipitofrontalis or the superior rectus of the eyeball. People with ptosis, as a rule, use the frontal muscle of their own accord for drawing the lid upward, and therefore present the characteristic deep wrinkles in the brow (see my *Atlas on External Diseases of the Eye*, Plate 9). If the ptosis is very great, such patients also find themselves obliged to throw the head backward, so as to bring the pupil into the palpebral fissure.

To determine what part in the elevation of the eye is played by the frontal muscle in a patient of this kind, pressure should be made with the flat of the hand on the forehead, which causes him to close the eyes. He is then requested to open the eyes wide and look straight ahead or slightly upward. As the action of the frontal muscle

is then excluded by the operator's hand, any elevation of the lid that takes place must be effected by the levator.

Fig. 118.—This is the same patient as the one shown in Plate 12. The large wound cavity remaining after the operation is here seen to be covered with pedunculated flaps taken from the forehead, while the wound in the forehead has been covered with flaps, after the method of Thiersch. The operation was performed by Krönlein. This picture was taken eight weeks after the operation.

There are a number of operations having for their object to increase the elevation of the lid in ptosis by means of the frontal muscle, chiefly by means of cicatricial bands

attaching the upper border of the lid to the region of the eyebrow. Among these operations are:

1. **Pagenstecher's Ptosis Operation.**—This is performed with either one or two sutures, each of which is armed with two needles. One needle is introduced under the skin of the upper lid, at a point 1 to 2 mm. from the palpebral margin, and running parallel with it; it is then reinserted exactly at the point of exit, and carried upward between the tarsus and the skin of the lid and brought out above the eyebrow (Plate 13, Fig. 1). The second needle is then introduced at the same point as the first, and also carried upward and brought out alongside of the suture of the other needle, above the eyebrow—after which the two sutures are tied. The suture is therefore entirely subcutaneous, and, if desired, a second one may be introduced. The sutures are allowed to remain in place for a variable length of time, and may be gradually pulled out and retied until they cut through the tissue, thus increasing the scar-formation.

2. **de Wecker's Operation.**—de Wecker combined the old ptosis operation by von Gräfe (excision of a semilunar piece of skin with the underlying orbicularis muscle from the upper lid) with Pagenstecher's suture. Hence, by mentally supplying this excision, Plate 13, Fig. 1 may be taken as an illustration of de Wecker's operation.

The object in excising the orbicularis muscle in von Gräfe's and de Wecker's operation is to weaken the antagonist of the levator. In cases in which the upper lid is thickened after trauma, inflammation, etc., excision of the skin also has the advantage of diminishing the weight of the lid and thus making it easier for the frontal muscle to elevate the lid, because it is less apt to elevate only the yielding skin instead of the lid itself.

3. **Dransart** has advised an operation similar to that of Pagenstecher's, except that his suture does not extend as far as the edge of the lid, but only as far as the upper border of the tarsus. He also brings his three sutures, each of which is armed with two needles, out above the

FIGS. 119-124.—Instruments for operations on the lid:
FIG. 119.—Beer's knife.
FIG. 120.—Knapp's lid clamp.
FIG. 121.—Jäger's horn plate.
FIG. 122.—Desmarres' clamp.
FIG. 123.—Wilder's double knife.
FIG. 124.—Snellen's lid clamp.

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eyebrow and ties them there. The short horizontal portion of the suture within the lid passes through the upper part of the tarsus (instead of through the skin of the palpebral margin, as in Pagenstecher's operation). By drawing the sutures more or less tightly the effect can be increased or diminished at will.

4. The operation of **Hess** is a marked improvement on that of Dransart. The eyebrow having been shaved, an incision is made running the entire length of the brow through the skin and the subcutaneous tissue. Through this incision the skin of the eyelid is dissected away from the subjacent layer of orbicularis muscle with a scalpel. After the hemorrhage, which is usually not marked, has been controlled, three sutures with two needles each are introduced from without inward through the upper portion of the dissected skin of the lid, so that when the sutures are drawn tight they form a fold in the skin, resembling as nearly as possible a corresponding fold in the normal eye. The sutures are carried upward underneath the skin, somewhat as shown in Plate 13, Fig. 1, and the needles are brought out above the incision; that is, at about the same point as in Pagenstecher's operation. There they are tied, and then allowed to remain in place for from a week to ten days. If necessary, they may be tightened from time to time. The wound in the eyebrow is closed with a continuous suture. The important feature of the operation is the formation of an extensive wound surface, the cicatrization of which permanently fixes the artificial fold in the upper lid. Another feature is that the sutures are carried upward, bringing the upper dome of the fold, which also belongs to the wound sur-

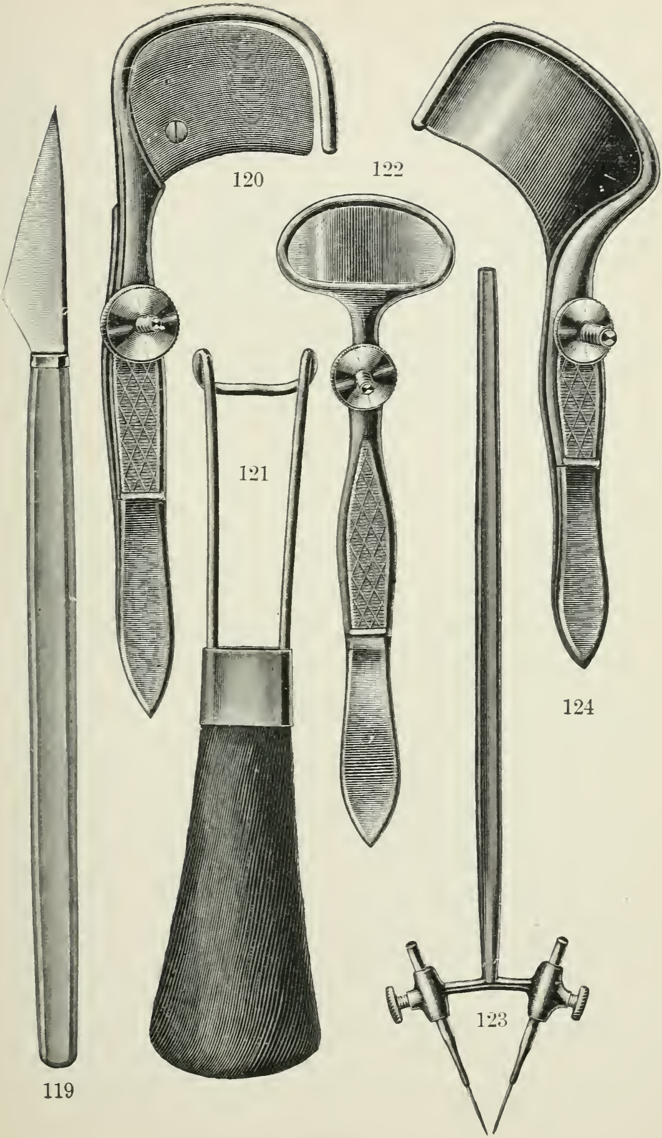

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Plate 13.

FIG. 1.—Pagenstecher's ptosis operation in a young girl with congenital ptosis.

FIG. 2.—Gaillard's suture in an old man with spastic entropion.

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face, into intimate union with the lower extremities of the muscle bundles of the frontal muscle, and thus enabling the latter to transfer much of its action to the lid.

5. In **Panas' operation** the lid is fastened to the frontal muscle by forming a skin flap about 8 mm. wide and 5 to 6 mm. high in the lid, undermining it carefully and directing it upward. This flap is then drawn up under the skin covering the region of the eyebrows. For this purpose a horizontal incision 3 mm. long is made immediately above the eyebrow and parallel with it; through this incision the skin between the eyebrow and eyelid is undermined, so that the lid flap can be drawn under this bridge of skin with sutures and fastened in place. The operation is very effective, but leaves unsightly scars in the upper portion of the lid.

6. **Motais' Operation.**—Instead of the frontal muscle, the rectus superior may also be utilized to assist in the elevation of the upper lid. This very useful and original operation of Motais is particularly adapted to cases of ptosis (especially bilateral cases), in which the levator muscle is entirely wanting. To secure good access to the operative field, the eye is first rotated downward with the single or double hooks, and the upper lid, after being everted, is drawn upward (Fig. 125). Ligatures may be used instead of hooks. A horizontal incision is then made in the bulbar conjunctiva and in Tenon's capsule, and the tendon of the superior rectus searched for. A tongue is then excised from the middle of the tendon, running as far as the insertion. A suture with two needles is passed through this tongue (Fig. 126), which is then, by means of this suture, inserted between the tarsus and the skin of the upper lid. For that purpose an opening is made with the scissors in the conjunc-

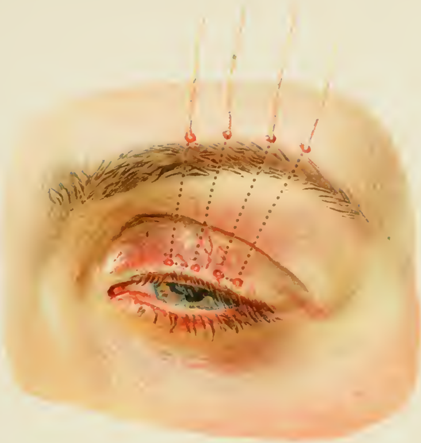


Fig. 1

Fig. 2

FIG. 125.

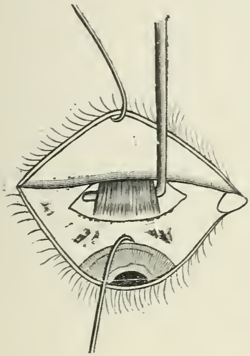
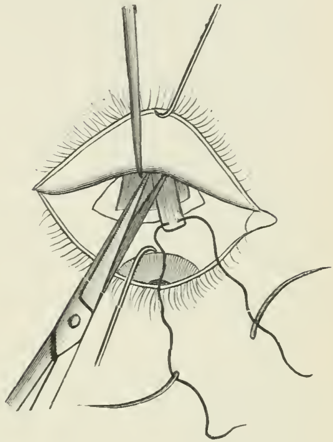


FIG. 127.



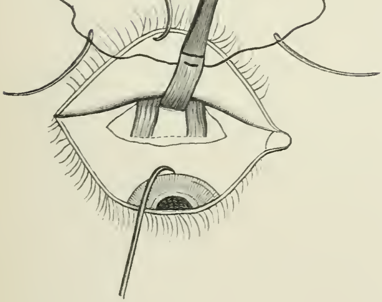


FIG. 126.

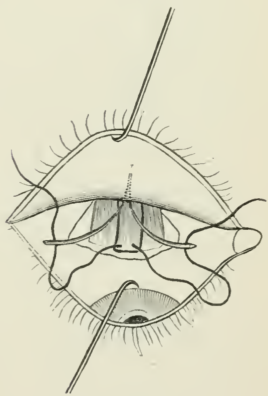


FIG. 128.

FIGS. 125–128.—Motais' ptosis operation (see text).

tiva, and in the levator tendon at the posterior extremity of the inverted lid; that is, at the upper border of the tarsus (Fig. 127). Through this opening a pouch is

made between the tarsus and the orbicularis muscle, extending to within 2 mm. of the edge of the lid, into which the suture with the two needles, and bringing with it the tongue-like piece of tendon from the superior rectus, is introduced (Fig. 128). The two needles are then brought out through the tarsus and the skin, at a distance of 4 mm. from one another, and the sutures tied on the outer side of the lid. Thus the tongue of tendon lies on the outer side of the upper tarsus. Postoperative depression of the eyeball, with corresponding vertical diplopia, which sometimes follows the operation, has always disappeared after a period varying from two weeks to five months at the latest in all the operations of this kind that have so far been reported.

Among the modifications of Motais' operation (for it also has already been modified) I may name that of Cannas, who stitches the tendon of the levator to the belly of the superior rectus muscle. A vertical incision extending over the entire lid is made for the purpose of finding the tendon of the levator palpebrarum superior; this is dissected away from the tarsus for a distance of 5 to 6 mm.; and at the same distance from the tarsus a catgut suture is passed through the tendon and the latter divided above the suture. The superior rectus is then exposed, and the peripheral ends of the levator approximated to the rectus by means of the catgut suture.

When the function of the levator is impaired without being entirely deficient, a very different method may be pursued. This is the case in many congenital or acquired forms of moderately severe ptosis with considerable cosmetic or functional disturbance. In such cases the muscle or the tendon may be shortened or the insertion may be placed more deeply; in other words, a kind of advancement may be made, a procedure which is quite out of the question when the muscle is entirely paralyzed or deficient. Among the many procedures of this kind the following may be mentioned:

7. **Ptosis Operation of Eversbusch.**—The patient having been anesthetized, Snellen's lid clamp (Fig. 124) is applied, pushed well up behind the affected lid. Before the clamp is closed the skin of the lid should be drawn

down as much as possible toward the palpebral margin, so that after the screw has been closed the prolongation of the lid (transitional fold and skin beneath the eyebrow) may be caught in the instrument. Midway between the edge of the lid and the eyebrow an incision is now made between the skin and the orbicularis layer, parallel to the palpebral margin; the skin with the subjacent muscle is then dissected away upward and downward to a distance of 4 mm. both ways, and loosened from its foundation, so that the upper transitional fold and the insertion of the levator at the tarsal plate of the lid can be exposed. The levator tendon is then drawn down by means of three vertical double sutures, or folded, so to speak. At the center of the tendon, above its insertion in the tarsus, a suture with two needles is inserted horizontally across, so that the points of entrance and exit through the tendon are about 2.5 mm. apart. Two needles are then carried outward on the tarsus—*i. e.*, between the tarsus and the orbicularis; brought out at the free border of the lids, also at a distance of about 2.5 mm., and tied over a glass bead in order to prevent them from cutting into the tissues. The two other sutures are introduced in the same way to the right and to the left of the central suture, in the temporal and nasal portions of the levator tendon, and carried downward, so that the tendon is drawn forward and outward by three separate loops. The skin wound is then closed, and a double bandage must be worn for several days.

Later, Eversbusch modified the operation in cases of paretic or paralytic ptosis by the addition of partial resection of the adjoining orbicularis muscle, after drawing the levator tendon to the upper edge of the tarsus. The advancing sutures were carried through the skin, frontal muscle, levator tendon, superior tarso-orbital fascia, orbicularis muscle, and the skin of the lid, and tied outside on the skin, over glass beads.

8. **Snellen** shortens the levator muscles by excising a horizontal oval piece. He makes a skin incision over the entire breadth of the lid, making it coincide as nearly as

possible with a fold in the skin. The orbicularis is divided and drawn apart. A little above the upper edge of the tarsus the orbitotarsal fascia is incised. The globe meanwhile is protected by a Jäger plate; the eyelid is drawn well downward, and from 2 to 5 curved needles with sutures are introduced in a fan-shaped arrangement through the levator muscle and tendon in the direction from muscle to tarsus; and on the needles an oval piece, with the long axis running transversely, is excised. The needles are then drawn through and the sutures tied. Later, Snellen merely introduced the sutures and tied them without excising the muscle and tendon. In mild cases he thinks the suture alone, without any skin wound, is sufficient. Both ends of the doubly armed suture are passed through the thickness of the lid, beginning at the fornix of the conjunctiva, one end as far back as possible through the conjunctiva and the muscle, and the other end through the broad edge of the tarsus; while the points of exit on the outside of the lid are brought close together and the sutures tied over beads.

9. Two other methods of shortening the levator or advancing it were suggested by **H. Wolff.**

By making a careful anatomic investigation of the insertion of the levator in the tarsus he discovered that the upper part of the tendon is inserted in the anterior surface of the tarsus, about midway between the upper and lower margins, along a line of insertion running horizontally and approximately parallel to the free border of the lid. This line of insertion is about 5 mm. distant from the free border of the lids at every point. The tendon is as strong and firm as that of one of the recti. The surface of the tendon gives rise to numerous connective-tissue plates running outward and forward between the bundles of orbicularis muscle (Schwalbe) and ultimately inserted into the skin. The upper border of the tarsus also gives insertion to the superior palpebral muscle of Heinrich Müller, which in an anatomic sense is also to be regarded as one of the tendons of the levator.

This insertion line on the tarsus, which Wolff discovered, makes it possible to use a shortening operation on the tendon like that performed by Schweigger on the recti muscles—*i. e.*, leaving the normal insertion and advancing the tendon by means of securely holding sutures.—Elschnig, however, whose procedure will be described later, denies the existence of this insertion as described by Wolff, on the strength of a great many anatomic preparations.

In one method Wolff exposes the levator tendon discovered by him in front of the upper portion of the tarsus, to a breadth (horizontally) of about 1 cm., by means of the two strabismus hooks, and shortens the tendon by resection in the same way as in Schweigger's operation for strabismus (p. 258). In his second method Wolff, after everting the lid twice, goes in after the muscle from the conjunctival side by dividing the conjunctiva horizontally.

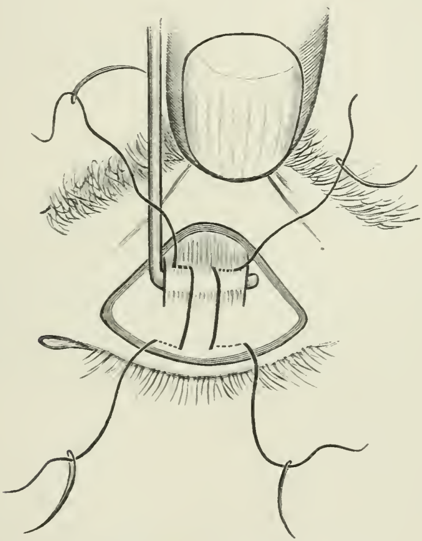


Fig. 129.—Lapersonne's ptosis operation.

The intermediate isolated portion of the muscle is also seized with two strabismus hooks of a measuring spatula and secured in the same way with catgut sutures, after which it is resected as in the above-mentioned procedures. Later, Wolff added a skin incision for the purpose of draining the wound and preventing swelling.

10. Recently, **Lapersonne** advised the following operation (see Fig. 129): Incision through the skin and

orbicularis, 4 to 5 mm. above the edge of the lid, exposing the tendon of the levator; two vertical incisions as far as the conjunctiva, to permit the introduction of a strabismus hook; introduction of sutures armed with two needles, one in the nasal and the other in the temporal portion of the tendon. After the tendon has thus been secured it is divided below the suture and, if necessary, a piece may be excised. The sutures are then passed through the tarsus, at a distance of 2 to 3 mm. toward the edge of the lid, and each suture is tied. In most cases it is better to excise a section from the skin of the lid as well as from the orbicularis. The skin wound is then closed.

11. **Elschnig,** in his operation for advancement of the levator to correct cases of incomplete ptosis, adopts yet another method: Skin incision parallel to the free edge of the lid and 3 to 4 mm. above it along the entire extent of the eyelid. The upper part of the skin of the lid is then dissected away in such a way that the greater part of the orbicularis remains bound to it, and is then drawn upward, whereby the lower half of the tarso-orbital fascia is exposed. The lid having been well drawn down to render the fascia tense, the latter is then incised about 10 mm. above the palpable convex border of the tarsus along its entire extent, in a line parallel to the edge of the lid. Immediately underneath the tarso-orbital fascia is the thin layer of the levator, which is exposed by gently pushing back the fascia. The levator is now seized at a distance of from 5 to 10 mm. above the convex border of the tarsus with a loop running perpendicularly to the axis of the fibers, and divided immediately below for a distance of from 3 to 4 mm., after which the division of the muscular layer along the entire extent of the lid is completed with scissors in a line parallel to the edge of the palpebral margin.

The peripheral portion of the divided tarso-orbital fascia is then undermined with scissors as far as the middle of the tarsus, or, rather, to the lower edge of the skin wound, so as to form a pocket, and entirely isolated

from the surface of the tarsus, so that the cartilage can be exposed by drawing up the bridge of fascia, which is only fixed to the two sides of the lid. The advancement of the muscular layer is effected by seizing the free proximal border with three doubly armed sutures, passing each suture through the bridge of fascia in a direction perpendicular to the edge of the lid, then introducing each needle vertically through the tarsus and conjunctiva along the lower edge of the skin wound and bringing it out in the same way 2 mm. above the free edge of the lid—*i. e.*, about 2 mm. from the line of the lashes, through the conjunctiva, tarsus, and skin, or, in other words, through the entire thickness of the lid from behind forward. Great care must be exercised to see that all the sutures are carried vertically through the lid. Each pair of sutures is passed through the lid, in the manner described, at a distance of about 3 mm. from the next, so as to draw the muscular layer down to the middle of the tarsus. The tarso-orbital fascia is then united again with two catgut sutures (it is best to introduce these sutures at the very beginning, when the fascia is divided), and finally, after the skin incision has been closed, the muscle sutures are also tied over sterile pledgets of cotton.

Instead of excising a piece from the tendon, some operators excise from the tarsus. The first of these was Boucheron, who excised a strip of tarsus along with the orbicularis, cutting in through the conjunctiva in order to avoid any scar in the skin. Similar procedures are recommended by Nicati, Heisrath, and Gillet de Grandmont. Later, Gruening again discovered this method of excising the tarsus and practised it to some extent. Marple had very good results with it in cases of traumatic ptosis.

12. **Gillet de Grandmont,** after applying a Snellen's clamp, incises the skin along a line parallel to the edge of the lid, 3 to 4 mm. away from it, making an incision about 2 to 5 cm. in length. The tarsus is thus completely exposed, and from it he excises a crescent-shaped piece, the lower border of which is 2 cm. long and runs parallel to

the edge of the lids, at a distance of 2 to 4 mm. from the same, while the upper curved incision is placed as far away from the lower incision as is necessary for the proper elevation of the lid. The conjunctiva is excised along with it. The edges of the tarsus are then united with three fine catgut sutures. It is not necessary to suture the skin.

Finally, it may be mentioned that there are cases of traumatic ptosis in which the tendon of the levator palpebrarum superior is torn and turned away from the tarsus and must be picked up and reunited to the tarsus with sutures. Green, in 1871, adopted this procedure with good success in a case in which complete ptosis had been produced by a blow from a cow's horn, the levator tendon having been completely torn away. In making a choice between the various methods in an operation for ptosis, it must always be borne in mind that closure of the lid must not be rendered impossible.

It is needless to say, also, that the operation selected must be adapted to the particular form of ptosis in each case. When the levator is completely paralyzed or absent, the only operation to be considered is one in which the frontal or superior rectus muscle is utilized. On the other hand, if the levator is only weakened, advancement or shortening of the tendon or of the tarsus is a perfectly proper operation. If the lid is lengthened and the tissues are thick, excision is especially indicated for the purpose of reducing the size and weight.

II. OPERATIONS FOR ENTROPION.

Spastic entropion is usually temporary and confined to the lower lid in old persons, especially after an occlusive bandage has been applied (after an operation or for keratitis). Aside from flaccidity of the skin and depression of the globe, the chief predisposing factor is blepharophimosis (Plate 4, Fig. 17), and the condition is best corrected by means of a Gaillard suture.

In some cases the condition, which is especially apt to be unpleasant in patients who have been operated upon for cataract, can be controlled by applying strips of adhesive plaster in such a way as to draw the skin of the lower lid away from the palpebral margin and toward the cheek :

1. By means of **Gaillard's suture** the skin of the lid is temporarily shortened, a fold being caught in one or two sutures. With the thumb and index finger of the left hand a horizontal fold of the skin of the lower lid is picked up and its base transfixed with the two needles of a doubly armed suture, entering about 3 mm. from the palpebral margin and emerging about 15 mm. below it. The second needle is introduced in the same way as the first, at a distance of 3 mm. from it, and carried downward. The sutures are then tied over a small piece of rubber tube or cotton pledget (Plate 13, Fig. 2). If desired, a second suture can be introduced in the same way. The sutures are removed after two or three days. The fold smoothes out again later, but in the meantime the irritation, which was responsible for the blepharospasm, as a rule, disappears.

If the entropion recurs the skin may be permanently shortened by excising a piece, the shape of a myrtle leaf, from the lower lid, quite near the edge, along with the subjacent orbicularis muscle, and closing the wound with a few sutures. A still better operation in these cases is that devised by Hotz (see p. 311).

The condition known as partial trichiasis, in which a limited number of cilia are turned inward and rub against the globe, is usually caused by small scars remaining after hordeolum, diphtheria, burns, or operations on the inner side of the lid.

2. The best treatment consists in **destroying the roots of the cilia by electrolysis,** as extraction of the misplaced cilia brings but temporary relief from the condition, which is often followed by corneal disease, or, at least, corneal irritation, for the cilia grow again in a short

time. Electrolysis is effected by means of a small sharp needle fixed in a holder, through which an electric current of about 2 milliampères from a constant battery of the necessary number of elements is passed into the needle. The latter forms the negative pole; while the positive pole, an ordinary flat electrode, after having been well moistened, is applied to the patient's temple or placed in his hand. It is well to inject a little cocain solution subcutaneously at the affected area of the palpebral margin,

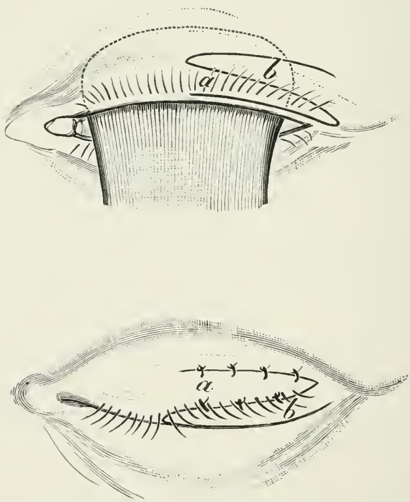


Fig. 130.—Trichiasis operation by Spencer Watson.

because, after the needle has been introduced into the follicle close to the eyelash, the closure of the electric current causes rather severe pain. After from five to ten seconds, during which small bubbles of hydrogen emerge from the tissue around the needle, the follicle will be destroyed, as appears from the fact that the eyelash either follows the needle as it is withdrawn or is removed by a very slight pull with the forceps; if it has not been destroyed the procedure must be repeated.

When the trichiasis extends over a larger area and includes, say, the outer or inner half of the palpebral margin, Spencer Watson's operation is indicated.

3. **Spencer Watson's operation** consists in transplantation of the misplaced cilia by displacing a flap (Fig. 130). An assistant having introduced a horn plate, the entire portion of the skin affected with entropion is loosened. With the thumb of the left hand the skin of the upper lid is drawn slightly upward, and the eyelid is then divided into a main anterior layer bearing the cilia, and a posterior layer composed of tarsus and conjunctiva, making the division as deep as may be required for the lower flap, *a*. This part of the operation is best performed with an iridectomy knife or a Beer's cataract knife (Fig. 119). Above this the main flap, *b*, is formed, and then the two are made to change places, so that *a* lies above, and the cilia are drawn away from the globe.

Complete (general) trichiasis, or extensive inward displacement of the cilia along the entire palpebral margin, requires an operation by which the position of the entire ciliary soil is altered. One of the best of the numerous operations that have been recommended for this purpose is known as

4. **Hotz's Operation for Entropion.**—The main objects of this operation are to draw away the skin from the cilia with the edge of the lid and fasten the latter to the tarsus and tarso-orbital fascia. It can be performed both on the upper and on the lower lid. In the former case the lid is drawn down over a horn plate, which may have to be dispensed with, and a horizontal incision is carried right across the lid. This incision should follow the curved line of the upper edge of the tarsus, the breadth of which is subject to individual variations. When the eye is closed the edge of the tarsus is readily recognized by a delicate wrinkle in the skin, beginning about 2 mm. above the inner canthus and rising gently to the middle of the lid, and from that point falling gradually to the external canthus. As it is difficult, owing to the extreme looseness of

the skin of the upper lid, to follow this curve with a knife, it is better to draw the lid well down in the manner described, as it has the effect of converting the curved into a straight line, which can easily be followed with the knife on the tense lid. This incision is carried from a point 2 mm. above the inner angle of the lid to a point 2 mm. above the outer angle. As soon as the skin has been divided the upper edge of the wound retracts (Fig. 131). The orbicularis is now cautiously divided exactly along

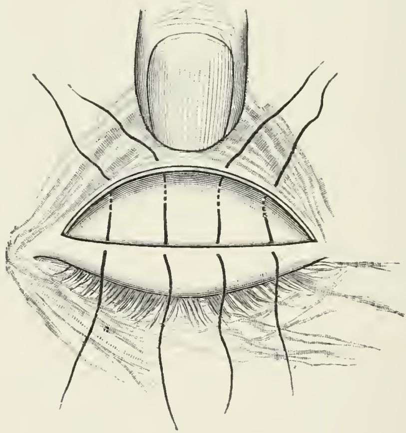


FIG. 131.—Hotz's entropion operation.

the lower edge of the wound until the yellowish-red color of the tarsus becomes apparent. The upper edge of the tarsus is readily recognized by the marked contrast between the yellowish tendinous color and the grayish-red color which shines through the tarso-orbital fascia at this point. The latter must not be wounded during this operation.

After the palpebral portion of the orbicularis has been separated in this way from the orbital portion throughout the entire width of the lid, and has been loosened from the tarsus along with the skin, the operator lets go the lid,

whereupon the wound at once ceases to gape and the incision exactly coincides with the curve, with the above-mentioned wrinkle in the skin. The assistant now turns the skin slightly backward at the center of the lower edge of the wound, so as to bring the orbicularis into view. The operator then seizes the muscle fibers nearest the edge of the skin with a delicate pair of forceps, and dissects away a strip about 3 mm. broad from the center of the edge of the skin to each angle. The edge of the skin and the upper portion of the tarsus must be absolutely free from muscle fibers.

In applying the sutures the needle is introduced first through the lower lip of the wound, 2 mm. from the edge, while the assistant pushes the upper lip of the wound upward with his index finger and the operator draws the lower one down. The needle is introduced 2 mm. above the upper edge of the tarsus, through the aponeurosis, passes upward along the tarsus, and made to emerge about 2 cm. above it through the tarso-orbital fascia. Finally, it is introduced through the corresponding point on the upper edge of the skin, care being taken that the sutures contain nothing but skin, and avoids the orbicularis fibers. Three or four such sutures are required, and care must be exercised to see that the skin edges are accurately approximated.

The eye is dressed with iodoform gauze and cotton, and the bandage may be dispensed with after from two to three days, when the sutures may also be removed.

The same procedure is recommended for the lower lid. When the skin is long and loose, especially in old people, the operator must be careful not to make the skin incision too far from the edge of the lid, so as to make sure that the skin is sufficiently put on the stretch on the tarsus. At the same time it may be advisable to excise a narrow portion of skin.

Should this operation prove not quite adequate in very marked cases, other auxiliary measures may be resorted to, as, for example, the secondary excision of a narrow

horizontal strip of skin near the edge of the lid. Or, when the inward inclination of the cilia is extreme, the condition may be corrected by splitting the free edge of the lid along its entire extent and separating the cilia-bearing portion from the tarsus, and then filling the cleft with a piece of skin from 2 to 3 mm. wide, taken from some hairless portion of the head where the skin is thin, preferably behind the ear, with Wilder's double knife (Fig. 123). I have had occasion to convince myself that this method of transplantation is very generally successful and produces a widening of the palpebral edge, as the transplanted strip of skin fits in between the cilia and the globe.

It is possible to combine with Hotz's operation excision of a narrow piece of the tarsus running parallel to the edge of the lid, in case it seems desirable to straighten the cartilage. Wilder's knife is convenient for this excision also.

Hotz's operation had a predecessor in the form of a similar procedure devised by Anagnostakis (1857), which, however, did not attract much attention. Anagnostakis placed the incision (in the upper lid) 3 mm. above and running parallel with the edge of the lid (that is to say, much nearer than Hotz's incision), removed the muscle fibers covering the upper third of the tarsus with forceps and scissors, and then secured the lower lip of the wound to the upper edge of the tarsus by means of sutures, which were allowed to slough out. This method of allowing the sutures to come away by suppuration is less commendable than the more accurate suturing advised by Hotz, followed by removal of the sutures after two or three days, as disfiguring vertical scars are produced by the process of suppuration.

5. **Entropion Operation with Advancement of the Levator Tendon.**—After Pagenstecher began to use Hotz's operation he soon expanded it into his own entropion operation with advancement of the levator tendon.

In this operation the surgeon stands at the patient's

head and finds the upper edge of the tarsus with the index finger of his left hand, which is an easy matter in most cases of entropion, because the tarsus is always more or less thickened. A short skin incision is made about 1.5 mm. below the upper edge of the tarsus as a landmark. The lid clamp is then introduced, taking care to clamp the lid straight, and a horizontal incision is made in the skin parallel to the edge of the palpebral margin at the point previously marked. This incision penetrates as far as the tarsus at the center, but on the two sides divides only the skin and extends exactly as far as the arms of the clamp. While an assistant depresses the lower lip of the incision downward at the center of the lid with a small pair of forceps, which he keeps closed, the operator, using the tip of the left index finger, pushes the upper lip of the wound upward at a corresponding point, so that the yellowish, tense tarsal tissue is brought into view. Next the upper half of the tarsus, and particularly the tarso-orbital fascia, must be exposed. The assistant pushes the bundles of orbicularis fibers downward while the operator pushes them upward, and the latter dissects away all the bundles lying above the incision—*i. e.*, the outermost curved fibers of the palpebral portion and the orbital portion of the orbicularis muscle—pushes them up with the tip of the index finger, and thus gradually cleanses the upper tarsus throughout its entire extent, and exposes the tarso-orbital fascia, the white color of which contrasts sharply with the yellowish tint of the tarsus, for a distance of 3 to 4 mm. above the center of the upper edge of the tarsus.

Next comes the most difficult part of the operation, namely, the introduction of the sutures. First a moderately curved needle with a medium-sized silk suture is carried through the skin and muscular tissue about 1 mm. above the edge of the lid and brought out on the inner surface of the lower edge of the wound, which has been picked up with the forceps. While the assistant draws the upper lip of the wound as far up as possible,

the operator, with a delicate rat-tooth forceps, takes firm hold of the tarso-orbital fascia about 2 to 3 mm. above the upper edge of the tarsus, and at the same time raises a fold of the tendon of the levator palpebrarum, which lies immediately underneath. The needle is then passed through the upper edge of the tarsus itself and the entire thickness of the fold of the levator tendon as it is vigorously drawn up, after which the needle is brought out through the upper edge of the skin wound. Two other sutures are then introduced in the same way, one on each side of the first, and, first, the central suture, and immediately afterward, the two lateral ones are tied as tightly as possible and the lid forceps removed. Double bandage; rest in bed; first change of dressing on the third day. On the fifth or sixth day the sutures are removed and no more dressing is applied.

This method, therefore, differs from that devised by Hotz in that no muscle bundles are removed, and the same cicatricial union is achieved between the orbicularis fibers on the one hand, and the upper edge of the tarsus with the fascia and the levator tendon on the other hand, the tendon being advanced and the direction of its action changed.

In other operative methods entropion is combated by altering the shape of the tarsus—*tarsoplastic operation*. This is effected by dividing the cartilage horizontally, or excising a horizontal wedge-shaped strip, thus causing outward rotation of the lower edge of the tarsus. Such an operation on the tarsus, however, is justified only in those cases in which, usually owing to trachoma, there is already such extensive disease of the tarsus that the Meibomian glands have all been destroyed, as the latter would otherwise be greatly injured by the procedure. The operation is especially adapted to the upper lid.

6. **Streatfield's entropion operation** includes excision of a prism-shaped piece from the cartilage, and should be mentioned first among these methods (1858). To control hemorrhage and keep the parts in the proper

position he used a Desmarres' clamp (Fig. 122), and carried an incision 2 to 3 mm. above the cilia along the palpebral margin over the entire width of the eyelid as far as the cartilage, without injuring the follicles. He then made a second incision parallel to the first and 3 mm. higher, which, by tracing a slight curve, was made to unite with the first at the temporal and nasal extremities. The two incisions are then continued into the tarsus until they meet, and in this way a long prismatic or wedge-shaped strip is excised, which is then dissected out along with the superimposed muscle and cutaneous layer with scissors and scalpel. In certain cases of simple entropion the knife must be handled very carefully, so as not to cut through the tarsus and the ducts of the Meibomian glands. Although this was laid down as a necessary condition of the operation, it is a condition that is not easily fulfilled. No sutures were introduced after the operation.

7. **Snellen's entropion operation** with excision of the tarsus was developed as a modification of Streatfield's. Snellen used his own lid clamp (Fig. 124), made an incision extending over the entire breadth of the eyelid, between 2 and 3 mm. above the cilia, and with the scissors excised the underlying muscle bundles. The wedge-shaped strip of tarsus was then excised by means of two oblique incisions extending almost to the posterior surface of the tarsus, and the wound was finally closed with three doubly armed silver sutures (sterilized silk is just as good). One needle is introduced through the upper portion of the tarsus, the second 3 mm. horizontally alongside of it, also through the tarsus, after which the needles are carried from the lower lip of the wound underneath the skin at the palpebral margin and brought out immediately above the cilia. Here the corresponding sutures are securely tied over a glass bead to prevent their cutting into the tissue. The skin incision requires no sutures.

8. **Hotz** himself, for certain cases of trichiasis of the upper lid, supplemented his above-described operation with a **tarsus excision.** This he did in cases in which

the free edge of the lid is rotated inward, owing to contraction of the conjunctiva and posterior portion of the tarsus, and lie in the same plane as the conjunctiva of the lid, so that the conjunctiva appeared to reach to the eyelashes. The inward rotation of the palpebral margin is accompanied by a similar inclination of the cilia toward the globe, with which they ultimately come in contact. In these cases Hotz restores the proper position of the palpebral margin by combining his above-described operation with excision of an oblique wedge near the edge of the lid. The first, lower, incision is carried vertically through the tarsus immediately above the follicles of the cilia; the second, above, running obliquely outward. The incisions meet in the posterior portion of the tarsus, about 3 mm. above the edge, in a line corresponding to the posterior edge of the inverted palpebral margin. After removal of the strip of tarsus the anterior edge of the lid may return to its normal position and the cilia resume their normal position perpendicular to the globe. After the hemorrhage has been controlled, 3 or 4 sutures are carried through the lower edge of the tarsus and ultimately through the upper edge of the skin wound.

9. **Division of the tarsus after Panas** is the method employed by the latter chiefly for cases of severe and obstinate trichiasis with entropion occurring in trachomatous subjects. He prefers Jäger's horn plate (Fig. 121), and makes his incision horizontally, 3 mm. above the row of cilia and extending over the entire lid to the tarsus. The latter is then completely exposed, both above and below, by dissecting away the orbicularis muscle with knife and forceps, but the cartilage is not excised. Below, the edge of the skin-muscle wound is undermined only as far as the cilia. If the tarsus is not abnormal it is allowed to remain intact; but if it is bent and thickened the entire structure, including the conjunctiva (that is, as far as the horn plate), must be divided in a direction perpendicular to its surface (Fig. 132). The needles are so introduced as first to seize the aponeurosis and the upper edge of the

tarsus; they are then passed underneath the lower lip of the wound and brought out immediately behind the cilia. Although the upper lip of the skin wound is not included in the suture, the wound closes, nevertheless, and after the sutures have been tied they are not cut off, but are drawn together in a bundle and fastened to the forehead, above the eyebrows. The sutures are removed after three to four days, and an occlusive bandage is worn a few days longer.

10. The **entropion operation devised by Pfalz** is related both to that of Snellen and that of Panas, and is

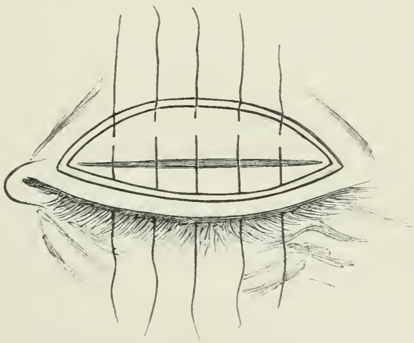


FIG. 132.—Entropion operation by Panas.

suitable for severe cases. The entire width of the lid is excised immediately above the lowest row of eyelashes, the edge of the knife being directed slightly upward and backward. By means of a second incision, running 3.5 mm. above and parallel to the first, a narrow flap of skin is outlined and then excised. The orbicularis may be excised in the entire operative field; the orbicularis is then also excised in the entire extent of the wound, and the tarsus having thus been exposed, a wedge-shaped piece about 2 mm. wide is excised from the base, the rounded apex corresponding to the point of greatest curvature of the tarsus. The conjunctiva is then also excised in a horizontal

line a distance of about 6 mm. along the middle of the flap, in order to increase the mobility of the palpebral margin. The needle is introduced from above through the skin and muscle, passes through the upper portion of the tarsus and the lower portion of the tarsus, and is brought out behind the last rows of eyelashes. Five sutures are used, which are also to be fastened to the forehead.

Snellen's suture is used for spastic entropion. The two needles of a doubly armed suture are brought out through the lid from the transitional fold, are then reintroduced through the point of exit, carried upward under the skin of the lid, brought out near the anterior palpebral margin and tied. Two or three such sutures are required. This procedure sometimes fails of any permanent effects, and is suitable only for the lower lid.

Ablation of the ciliary border after Flarer and the improvement on the operation by Stellwag, who ablated the ciliary border and, after rotating it through 180 degrees, replaced it in the wound (plastic operation on the palpebral margin), are hardly as good as the above-described methods, and are certainly suitable only for the lower lid.

Displacement of the ciliary border after Jasche-Arlt is performed as follows: An intermarginal incision is made and the cilia-bearing edge of the lid is undermined a distance of 4 to 5 mm. A crescentic-shaped piece is then excised from the skin of the lid, which has the effect of drawing the skin along with the cilia away from the palpebral margin and leaving the latter freely exposed for the formation of granulations; or, according to Waldhauer, the palpebral margin is covered with the excised piece of skin (non-pedunculated transplantation). This operation is no better, and often does less good, than the above-mentioned procedures. It was first proposed by Aetius and Paul of Ægina.

III. OPERATION FOR BLEPHAROPHIMOSIS.

Canthoplastic Operations.

Entropion is not infrequently produced or favored by blepharophimosis (Plate 14, Fig. 1), which consists in a vertical fold of skin covering the external canthus and, therefore, apparently shortening the palpebral fissure; although, when the fold is displaced toward the temple, the external canthus is seen to be intact (while ankyloblepharon is caused by cohesion of the palpebral margins). Blepharophimosis is usually caused by shortening of the skin at the outer canthus in a horizontal direction, as in chronic conjunctivitis, the skin becoming excoriated from contact with the lacrimal fluid and other secretions, and ultimately undergoing contraction. The process is aggravated by periodic blepharophimosis and senility.

Operation.—The anomaly is corrected by dividing the external canthus in a horizontal direction. The lids are first well separated and at the same time drawn tense toward the nasal side, and the external canthus is divided horizontally with one snip of a heavy pair of scissors, after which the conjunctiva is stitched into the wound (Plate 14, Fig. 2), so as to cover it, as otherwise the edges of the wound would rapidly grow together again. The needle is inserted first into the conjunctiva. The first suture is placed in a horizontal direction, and the two others in a direction outward and upward and outward and downward through the skin and then tied, whereby the conjunctiva is drawn into the wound. A bandage should be worn for several days.

Simple division of the external canthus without introducing sutures—provisional canthoplastic operation—is done in cases of blepharospasm leading to entropion and in gonorrheal conjunctivitis of adults to diminish the pressure exerted by the overstretched lids on the cornea; also in enucleation and exenteration of the orbit, as has been mentioned.

Plate 14.

FIG. 1.—Blepharophimosis in an old man: Vertical fold of skin in front of the outer canthus.

FIG. 2.—Canthoplastic operation: Enlarging the outer canthus.

IV. TARSORRHAPHY.

The outer or inner canthus may be united with sutures for exactly the opposite purpose as that for which the operation just referred to is performed, namely, to shorten the palpebral fissure in a horizontal direction.

a

b

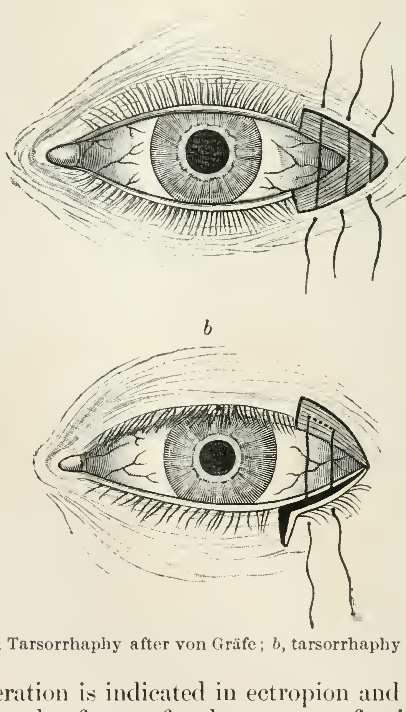


FIG. 133.—*a*, Tarsorrhaphy after von Gräfe; *b*, tarsorrhaphy after Fuchs.

This operation is indicated in ectropion and in lagophthalmos; in the former for the purpose of raising the lid

and obtaining better adaptation to the globe, and in the latter to provide a better protection for the staring eyeball by securing freer action of the lid. For the latter purpose the operation is also performed in exophthalmos due to Basedow's disease.

The operation is performed more frequently at the outer than at the inner canthus. The older method (von Gräfe's) consisted chiefly in cutting away the ciliary bed from the outer angle, freshening up the edges, and then uniting them with sutures (Fig. 133, *a*). Later, Fuchs suggested the following improvement: In the lower lid a small flap is secured by splitting the lid along the margin, dividing it into two layers, and then adding a short vertical incision, as shown in Fig. 133, *b;* the ciliary border of the upper lid is then freshened up and the inner surface of the flap united to it with sutures. The two ends of a doubly armed suture are passed through the upper lid near the free border, the needles being introduced from behind forward. The loop of the suture thus lies on the conjunctival side of the lid, while the free ends emerge from the anterior surface of the wound. The ends are then carried through the lower flap and tied over a glass bead. In this way the base of the flap is pressed against the raw surface of the tarsus of the upper lid, and a broader cohesion surface is secured than with von Gräfe's operation.

Nasal tarsorrhaphy after von Arlt consists in excising a narrow <-shaped strip of skin with forceps and scissors, both from the lower and the upper edge of the inner canthus, and uniting the two limbs of the wound with vertical sutures.

V. OPERATIONS FOR ECTROPION.

Cases of spastic ectropion in which the palpebral margins are forced outward by the swollen conjunctiva and then by the contraction of the orbicularis muscles, so that eventually the lower or the upper lid or both become

Plate 15.

FIG. 1.—Ectropion due to facial paralysis in the second year of life: The woman is now fifty-two years old, and complains of profuse lacrimation, the lower lacrimal punctum was dilated with a conical sound before the picture was taken.

FIG. 2.—The same eye after six months, after median tarsorrhaphy with Szymanowsky's modification.

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inverted, may be corrected by means of Snellen's suture, which represents the analogue of Gaillard's suture for the correction of ectropion.

1. **Snellen's suture,** like Gaillard's suture on the outside of the lid, is designed to effect a shortening of the inner side of the lid by means of one or two sutures. The two needles of a doubly armed suture are introduced at the level of the deformed lid, 3 mm. apart, between the conjunctiva and the tarsus, in a direction downward and obliquely forward, and brought out through the skin near the orbital margin at the same distance of 3 mm. from one another, where they are tied over a small drainage-tube. Obstinate (senile, paralytic) cases of ectropion will not be permanently cured by this method of suturing.

For paralytic ectropion of the lower lid tarsorrhaphy is a better operation.

2. For old advanced cases one may recommend **Szymanowsky's operation,** in which the lower lid is thoroughly elevated at the inner or outer canthus, while the related operation of Dieffenbach merely effects tension and shortening of the lid in a horizontal direction. Dieffenbach's operation consists in making a skin incision running toward the temple, in the line of the palpebral fissure, and adding two incisions running downward from the extremities of the skin incision and converging to form an equilateral triangle; the sutures are introduced horizontally after the adjoining palpebral margin has been freshened up. In Szymanowsky's method elevation is effected by excising a flat triangle, the obtuse angle of which coincides with the canthus, while the hypothenuse runs in a vertical direction at some distance from the

Fig. 1.

Fig. 2.

angle of the lid. In the case shown in Plate 15, in which the operation was so performed for old ectropion due to facial paralysis, the vertex of the triangle was placed slightly to the nasal side of the lower lacrimal punctum. From this point the first incision was carried past the inner canthus and extended for 1.5 mm. in the direction of the inner extremity of the eyebrow; the second almost vertically downward a distance of 2.5 cm.; and the third back to the starting-point. After this triangle of skin had been excised and the first incision had been prolonged a distance of 0.5 cm. toward the cilia, the edges of skin over the denuded portion were united with sutures running obliquely from without and below inward and upward, so that the beginning of the skin suture occupied a point to the nasal side of the lower lacrimal punctum in the upper angle of the triangle referred to. The effect of this procedure (as Fig. 2, which was taken six months after recovery, shows) may be quite marked.

Senile ectropion of the lower lid, which is quite common, and some cases of paralytic ectropion, may be suitably relieved by the operation now to be described.

3. **Kuhnt's Ectropion Operation.**—Kuhnt also excises a triangle, the base of which, however, coincides with the palpebral margin, which consists not of skin, but of the posterior layer of the lid, tarsus, and conjunctiva. The elongation of the lid, and especially of the palpebral margin, present in ectropion is successfully corrected by means of this operation. If the cutis is also excised—that is, a triangular piece is excised from the entire lid, as recommended by Adams in 1812, it may happen that the wound, owing to the traction on the edges of the skin flap by the transversely divided muscle bundles, fails to unite and a gaping cleft remains in the lid (coloboma).

An operation similar to that of Kuhnt was described by Antyllus about 300 A.D. The operation can readily be performed under local anesthesia (injection of cocain and adrenalin into the lid). Knapp's forceps (Fig. 120) may be used, but upside down, applying the flat piece to

Plate 16.

Senile ectropion in a woman sixty years of age, with senile cataract (see following Plate).

Plate 17.

FIG. 1.—Kuhnt's ectropion operation in the same patient.

FIG. 2.—Same eye three months after the operation and one month after cataract operation without iridectomy. Some secondary cataract remains, which was later successfully treated by discission.

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the skin and the curved part to the conjunctival side; or the lid may be seized between two spatulas in such a way as to leave the triangle to be excised between them (see Czermak[1]); or the lid may simply be held between the thumb and index finger of the left hand. The length of the piece of the triangle which is to be excised from the center of the lid is determined by the degree of shortening that is desired. A broad keratome is first inserted into the lid, along the free border, between the cutis and tarsus, after which a Λ-shaped piece of tarsus and conjunctiva is excised with small straight scissors, beginning at the extremities of the intermarginal incision (Plate 17, Fig. 1. Operation on the patient shown in Fig. 16). The sutures are then introduced as shown in the figure. The first suture, which is placed in the skin, should be particularly strong and take a deep hold on the skin edges. As soon as the sutures have been tied the skin is, of course, puckered into a fold, which stands vertically to the lid. This fold may be disregarded, however, as it becomes obliterated in a few weeks (compare Plate 17, Fig. 2), and if it fails to do so, as in severe cases of ectropion, a small superficial wedge of skin may be excised from two to three weeks later and the edges sutured together.

The fold in the middle of the lid just referred to can be avoided by adopting L. Müller's modification of the operation. When the keratome is introduced the lid is split further toward the temporal or nasal side than is necessary

[1] von Siklosy, in performing Adams' operation, held the lid between two fixation forceps in such a way that the points met at the bottom of the conjunctival sac.

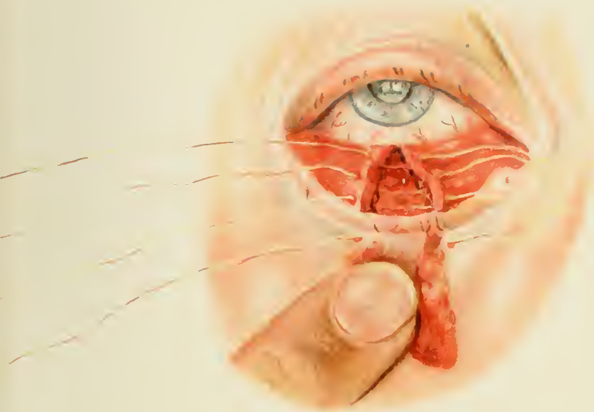

Fig. 1.

Fig. 2.

for the excision of the triangle, so that the intermarginal incision is about twice as large as in Kuhnt's operation. In placing the sutures the excess of skin (fulness) is then distributed over the intermarginal incision, so that instead of one large fold a number of small ones result (see Plate 18, Fig. 1, before the operation; Fig. 2, immediately after the operation, and Fig. 3, a few weeks later), which soon become obliterated. But in doing a Müller's modification I found it necessary to see that the tarsal sutures which take the place of the excised triangle have a secure and deep hold on the cartilage, because the first suture of Kuhnt's operation, which is inserted in the skin and is very necessary for securing firm closure, is not used in the modification.

Another modification of Kuhnt's operation was recommended by Dimmer. By combining it with Dieffenbach's ectropion operation—that is, excising from the temporal end of the lid a triangular piece of skin with the base in the prolongation of the palpebral fissure, he is able to displace the excess of skin at the center of the lid (fulness) toward the temple, after splitting the lid into two layers in the direction of the temple as far as the skin triangle. That is to say, a triangle consisting of tarsus and conjunctiva is excised from the center of the lid, and a triangle of skin from the temporal end of the lid, after which the skin is displaced in that direction so that no puckering takes place at the center of the lid.

Cicatricial ectropion in most cases presents much greater difficulties.

In a general way the principle holds good that no attempt to correct the condition should be made until cicatrization is complete, because the subsequent cicatricial contraction would otherwise interfere with the result of the operation. Occasionally mere subcutaneous division of a few cicatricial bands, as, for example, after caries of the edge of the orbital margin, may improve the situation; but, as a rule, especially in extensive scars after burns, cauterization, injuries, necrosis, caries of the orbital margin, etc., the entire

Plate 18.

Fig. 1.—Senile ectropion in a man seventy-three years of age. The right eye has been running for two years, although the nasal duct is permeable. The conjunctiva of the lower lid is greatly swollen and reddened from catarrh.

Fig. 2.—Same eye immediately after Kuhnt's ectropion operation with L. Müller's modification.

Fig. 3.—Same eye three weeks later, after recovery.

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scar has to be excised, no matter how deep it extends into the tissue, in order to mobilize the lid. The latter is then restored to its proper position and the excised portion covered with skin, either by taking a pedunculated flap from the immediate neighborhood or skin grafts after the Thiersch method. In other words, it is frequently necessary in these cases to restore destroyed parts of the lid, especially the skin, by means of a plastic operation.

Blepharoplastic Operations.

Whichever method is employed for the transplantation, the first rule must be to preserve the palpebral margin and the adjoining portion of the lid as nearly intact as possible, because it is almost indispensable for the proper framing of the palpebral fissure.

In many operations of this kind tarsorrhaphy, or temporal suturing of the misplaced lid, becomes necessary as an auxiliary measure.

First of all the lid in these cases of cicatricial ectropion must be rendered perfectly movable by separating and excising the scars, in order that it may be restored as nearly as possible to its normal position. In order successfully to cover the defect with skin grafts after the Thiersch method, it is absolutely necessary that the upper lid be drawn down over the lower one, or the lower lid up over the upper one (see Plate 20). This is best accomplished by means of a few skin sutures.

A skin flap, whether pedunculated or not, in contracting loses at least $\frac{1}{3}$ of its length and breadth; there is a difference, however, between contraction of the trans-

Fig. 1

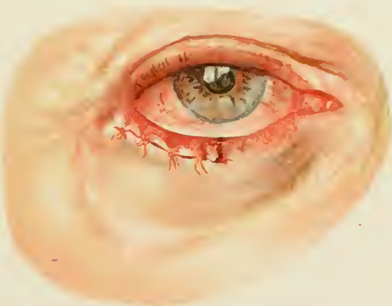
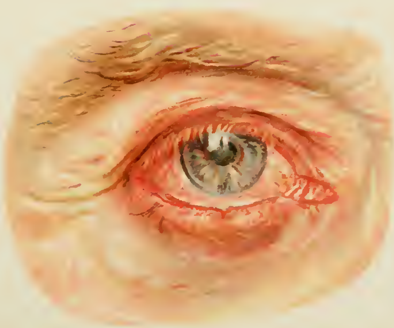


Fig. 2



planted skin and contraction of the underlying layer. If the latter consists of cicatricial tissue, it will continue to contract for some time after the operation, and along with it the superimposed skin will, of course, also contract, so that at last practically nothing will be left of it. For this reason it is very important to excise as much as possible of the cicatricial tissue in the operative field, including that contained in the subcutaneous cellular tissue, and, if necessary, to extend the incision as far as the orbital margin and the tarso-orbital fascia, especially if it is desired to employ the Thiersch method.

The choice between the latter method and the use of a pedunculated flap sometimes depends altogether on circumstances. If the skin surrounding the lids is also distorted by cicatricial contraction, as, for example, in the case shown on Plate 22, a skin-grafting flap will have to be resorted to, because the most important rule in employing a pedunculated flap is that the flap shall consist as much as possible of normal skin, and especially that the insertion or pedicle shall not be in the scar tissue, as in that case the flap in its new position would be imperfectly nourished and in danger of becoming necrotic. After the flap has been brought into its new position, it must not be distorted and the sutures must not be placed while it is stretched. In dissecting the flap it should not be made too thin, but should retain some of its subcutaneous fat, which at first favors nutrition, although it later atrophies. The pedicle of such a flap should always be as broad as possible, and the breadth should be in proportion to the length (see Plate 29). It is always important to see that there is no hair included in the flap, as it continues to grow uninterruptedly after transplantation.

Of the innumerable methods of obtaining a pedunculated flap and placing it in its new position—variations which often look better on paper than in *vivo*—Fricke's and Dieffenbach's blepharoplastic methods are the most important. Fig. 134 illustrates only one example of this method, for the flap, which is tongue-shaped or may have

any other form, may also, as, for example, in the case of the lower lid, be taken from the skin of the cheek, or the pedicle of a flap taken from the brow may be attached to the bridge of the nose (Plate 29). Excessive rotation should always be avoided in bringing the flap into position. In size it should be one-third larger in every dimension than the defect which it is to cover. The fold which is sometimes left at the base of the flap after rotation may be disregarded, for it usually flattens out later or may be reduced afterward by excision. If the flap has

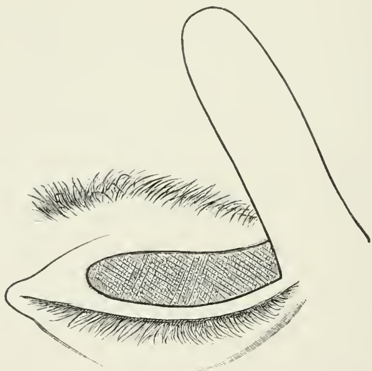


FIG. 134.—Fricke's blepharoplastic operation.

been made a little too small, it is better to cover as much of the wound as possible without stretching it, and cover the remainder with skin graft. Any attempt to increase the size of the flap by pulling and stretching is useless. It should be securely sutured in whatever position it assumes when it is applied to the defect. Hence, care should be exercised in cutting the flap to see that it fits as accurately as possible into the defect which is to be covered. After all the bleeding has been stopped the sutures are introduced in such a way as to fasten the edges securely.

In this method, as well as in that of Dieffenbach, the denuded area from which the flap has been taken is closed as well as possible with sutures, or at least reduced in size as much as possible after the edges have been undermined and loosened. The rest of the area may be covered with skin grafts after the method of Thiersch.

With Dieffenbach's method it is possible to cover a triangular defect (Fig. 135) by taking a rhomboid flap from the adjacent area, loosening it from its bed, and displacing it laterally until it covers the defect. The dotted line in Fig. 135 indicates the upper limit of the Dieffenbach flap; but as the flap at once contracts it should be made a little larger (solid line). The broader the triangle

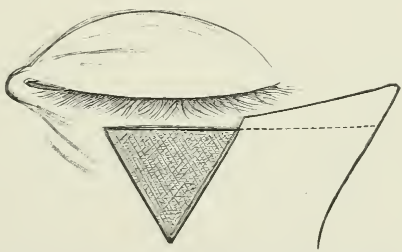


FIG. 135.—Dieffenbach's blepharoplastic operation.

to be covered—that is, the larger the lower angle—the higher should be the boundary of the flap, as was pointed out by von Siklosy, who, like von Arlt later on, also advised making the base of the flap narrower than the upper limit, which in fact renders rotation of the flap easier. By extending the apex of Dieffenbach's flap further toward the temple, the flap of Szymanowsky's modification is obtained.

In applying a bandage during the after-treatment of lid operations with pedunculated flaps, care must be exercised to avoid making pressure on the flap with the bandage, or distorting it when the dressing is changed. The wound as well as the palpebral fissure should at first be covered

with iodoform gauze, because there is always some secretion. The first dressing may be left in place for from three to four days. To secure perfect rest it is often necessary to bandage the other eye for twenty-four to forty-eight hours. Before changing the dressing it should be thoroughly saturated with warm sterilized physiologic salt solution or with bichlorid solution, 1 : 5000, and the irrigation is continued while the gauze, which adheres to the wound, is being removed. The sutures may be removed in from five to six days, after which a dressing with borated vaselin or pure vaselin is of advantage.

The operative treatment of cicatricial ectropion, as well as blepharoplastic operations in general, have greatly profited by **Thiersch's method of skin-grafting,** which may be used either to cover primary defects in the lid or as a secondary procedure to cover the denuded area from which a pedunculated flap has been taken, as, for example, on the forehead, cheek, etc.

Although a pedunculated flap, if it can be obtained under favorable circumstances, is to be preferred to a flap without a pedicle, because the result is more prompt, nevertheless the value of Thiersch's method of skin-grafting is considerably greater than Valude and Czermak would have us believe. I can not help agreeing with Kuhnt, who has made a special point of practising this method, Sachs, and certain others, that when the method is used in the right place and properly carried out it yields very good results. Thiersch's method is obviously most satisfactory in cases in which there are scars in the neighborhood of the affected eye, making it difficult or even impossible to obtain a pedunculated flap. But even when this is not the case, the grafting operation may have certain advantages over the plastic operation with a pedunculated flap, as, for example, when for cosmetic reasons it is desired to avoid disfiguring the parts surrounding the eye with the scar left by the removal of a pedunculated flap, as these scars are sometimes quite large.

On the other hand, it must be admitted that the employment of nonpedunculated flaps is often followed by a very unpleasant secondary contraction, so that in difficult cases with severe cicatrization repeated grafting often becomes necessary. The fault in these cases, however, lies not in the transplanted skin, but in the fact that excision of the subcutaneous cicatricial tissue has not been sufficiently thorough, sometimes because it is impossible to do so. This subcutaneous cicatricial tissue then undergoes further contraction, and in this way may cause unpleasant secondary contraction whether the flap is pedunculated or not. It is therefore important to take the trouble to free the operative field from cicatricial tissue as thoroughly as possible. If the entire tis-

sue is traversed by extensive bands of scar tissue, Kuhnt's plan of making a number of linear incisions throughout the large cicatricial area—that is, dividing it into small independent areas by intervals, which are free from cicatricial tissue, may prove useful.

Skin-grafting may be done at once if the hemorrhage has stopped, or at all events in a few days, in which case the area will have to be anesthetized by subcutaneous injection of cocain.

In my experience it is best to cut as large and thin a piece of skin as possible for skin-grafting, using a sharp planoconcave knife and taking the grafts from the inner surface of the upper arm, while an assistant seizes the limb on the outer side and stretches the skin as much as possible by pulling on the soft parts. The skin as well as the knife should be well moistened with physiologic salt solution, so that the flap will lie in wrinkles on the blade instead of sticking to it. To transfer the flap to the wound, the end is fixed with the point of a straight needle and the flap gradually paid out by slowly withdrawing the knife in the direction in which the longitudinal flap is to be laid on the wound. In this way the possibility of applying the flap with the dermal side outward is avoided. Thin flaps are better because they are less apt to roll up, and are therefore more easily made to lie smooth on the wound. Large flaps after the Thiersch method have this advantage over small, very thin flaps as recommended by Eversbusch, that the area of skin-grafting appears less tessellated.

This tessellated appearance is often quite marked after transplantation with small flaps, particularly with Reverdin's method. Thus, in the case shown in Plate 22, the right side of the face, which had been scalded by escaping steam, and had been treated elsewhere by Reverdin's method three years before the picture was taken.

Skin-grafting also has the advantage that it can be repeated in a difficult region more readily than transplantation of a pedunculated flap, and with patience and perseverance the method may in such cases in the end lead to a permanently good result. The case of enormous cicatricial ectropion shown in Fig. 1, Plate 19, in which, owing to caries of the orbital margin and of the temporal

Plate 19.

Fig. 1.—**Severe cicatricial ectropion,** the result of caries of the orbital margin, which had been present from the fifth to the fourteenth year of life. The patient is a male, fifty-two years of age. As a result of the insufficient covering of the cornea by the upper lid the membrane has become opaque, vascular and superficially indurated ; the eye, as a result, became blind and divergent. The temporal portion of the upper lid is adherent to the upper and outer edge of the orbit, which presents a deep gap, so that the lid is inserted far back in the cavity. A wide strip of the conjunctiva of the upper lid is constantly in view whenever the eyebrow is slightly raised. Admitted February 10, 1902. Separation of the upper lid from the bone to permit closing the palpebral fissure with sutures. Second operation February 23: Skin-grafting after Thiersch to cover the large defect with skin from the upper arm. Good recovery; discharged March 25. The eye can be completely closed.

Fig. 2.—The same eye six months later. The eye can not be closed entirely, but enough for practical purposes. The patient was again seen a year later and the same satisfactory result was found.

Plate 20.

Fig. 1.—**Cicatricial ectropion** in a man, nineteen years of age, who had been burned with molten lead at the upper outer angle of the lid. First operation September 27, 1902: the lid was separated as far as the tarso-orbital fascia, the scar excised, and the upper lid drawn down and attached to the cheek with a suture (Fig. 2). Four days later the defect was covered with skin after the Thiersch method.

Fig. 2.—Showing the wound before the skin-grafting.

Plate 21.

The same eye two weeks later, after uninterrupted recovery. Closure of the palpebral fissure is perfect.

On November 16th, and again on December 16th, however, a secondary and a tertiary operation, although not as extensive as the first, had to be performed, after which the condition shown in Plate 21 persisted permanently, although in ordinary closure of the eye the palpebral fissure gapes 2 mm. at the temporal extremity.

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bone, the upper lid was attached far back on the defective orbital margin, was relieved by an operation consisting in separating the lid and drawing it down as far as possible. Almost the entire skin of the lid had to be made anew, as there was only a narrow remnant along the palpebral edge. The result (Plate 19, Fig. 2) has persisted unchanged for three years.

Fig. 1.

Fig. 2.

Fig. 1

Fig. 2

In the case of the patient shown on Plate 20, on the other hand, three operations were necessary before a permanent cure was effected, probably because I operated a little too early. The deep burn was caused on the 10th of June, by molten lead, and the ectropion shown in Fig. 1 resulted. On September 27th the lid was divided so as to separate the palpebral margin, and the latter drawn down as far as possible and secured with a suture (Plate 20, Fig. 2). On October 1st the defect was covered after the Thiersch method, and on October 15th the condition shown in Plate 21 had developed. Later, however, the outer portion of the lid again contracted, so that the skin-grafting had to be repeated on November 16th and again on December 16th, although the subsequent operations were not quite so extensive as the first. The final result corresponds to the condition shown on Plate 25. The patient is just able to close the palpebral fissure. It would perhaps have been better to excise a little more of the scar in the prolongation of the eyebrow.

A case like the one shown in Plate 22 obviously requires much more work. Although three years had passed since the burn was sustained and cicatricial contraction had ceased, the scar tissue extended far into the tissue and there was almost no skin left on the lid. The enormously lengthened palpebral edges and the hypertrophied conjunctiva gave rise to further difficulties, so that the result shown on Plate 23 was not achieved until the skin had been loosened five times and the skin-grafting operation performed each time. In addition Snellen's suture and tarsorrhaphy had to be resorted to. The picture, which was painted two months after the last, and one year after the first, operation, shows a result which well repaid all the trouble, and which, as subsequent observations proved, remained permanent.

In this case it would have been impossible to use a pedunculated flap, except possibly by resorting to the Italian method, which consists in training the patient for weeks until he can tolerate having his arm fixed with bandages or a plaster cast until a flap taken from the arm has

Plate 22.

Enormous cicatricial ectropion in a man, twenty-three years of age, who had suffered a deep burn on the right side of the cheek three years previously from escaping steam, and had been treated elsewhere by the transplantation of small pieces of skin after the Reverdin method (without the coöperation of an oculist). Slight vascular clouding and small reflecting ulcers on the lower portion of the cornea. Enormous elongation of the palpebral margin. First operation February 14, 1902; both lids were divided until they were quite movable and the palpebral fissure could be closed with sutures (without freshening up the edges). Four days later the large wound was covered with skin from the arm after the Thiersch method. In March and April the operation was repeated on a smaller scale because the ectropion continued to recur. In July and November of the same year the operation was again repeated. In April tarsorrhaphy at the outer canthus was added.

Plate 23.

The same eye on February 5th, three months after the last operation. There is good closure of the palpebral fissure. Subsequent observation showed that the result was permanent.

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had time to grow fast to the eyelid, after which the flap is divided. In favorable cases this requires from six to eight days, but, unfortunately, the discomfort of the forced position of the arm lasts just as long.

In the case illustrated on Plate 24, in which the nasal portion of the lid had been destroyed a year previously by a dog-bite, and the remaining temporal portion had become the seat of cicatricial ectropion, a simpler operation sufficed to correct the deformity. Only one transplantation was done, the deficiency being supplied by a pedunculated flap taken from the upper lid after the method of Fricke. It would have done no harm, however, if another attempt had been made to raise the lid still more, but the patient was satisfied. The grafted skin underneath the palpebral border may be recognized by its paler color.

Before examining more closely into blepharoplastic operations in the narrower sense of the term—that is, the entire or practically entire restoration of eyelids, including the conjunctival portion—let us devote a moment's attention to the operative correction of scars on the inner side of the lid that have led to adhesion of the lid to the globe, or symblepharon. The condition is usually due to the

adhesion of opposed raw surfaces on the lid and on the globe, more rarely to cicatricial contraction of the conjunctiva as a result of pemphigus or trachoma.

If the adhesion is at all extensive the **operation for symblepharon** is usually a very difficult undertaking, and is often followed by only a moderately good, or even an unsatisfactory, result. But in this condition, also, matters have been improved since the invention of the method of transplantation, especially of thin pieces of skin.

Less extensive adhesions, such, for example, as are produced by burns or cauterization of the lower transitional fold and adjoining palpebral and bulbar conjunctiva, are best removed by the method of von Arlt, as shown in Plate 26. In this case the parts had been converted into an extensive eschar by the burning of the molten iron (Plate 25, Fig. 2), and this had been followed by cicatricial adhesion between the eyelid and the globe, extending as far as the cornea (Plate 26, Fig. 1). Mere division of the adhesion and the insertion of a disk of metal or glass to prevent the parts from growing together again, as was formerly done, is perfectly useless; nor is the method of any avail to avoid symblepharon in recent cases. The process of adhesion between the parts is so powerful that all such objects are gradually forced out, and it is therefore absolutely necessary, after the adhesion has been divided, to see that both the palpebral and the bulbar wound are covered with conjunctiva, or at least one of the wounds should be so protected against adhesion with the opposite wound. It may be possible to cover both wounds by reflecting the bridge of conjunctiva, which is put on the stretch as the lid is drawn down, toward the transitional fold and closing the bulbar wound by a horizontal row of sutures. The reflection is effected by means of a doubly armed suture, which is drawn through the bridge of conjunctiva, as shown in Plate 26, Fig. 1. If the conjunctiva, as sometimes happens in these cases, is drawn up to the cornea in the form of a pterygium, the

Plate 24.

Fig. 1.—**Cicatricial Ectropion after a Dog-bite**: The patient, a woman, forty-nine years of age, had been bitten a year previously by a large dog, so that the lower lid hung down. The family doctor cut off the dependent portion (evidently the nasal half of the lid), on the ground "that it was lost, anyhow." That was a great mistake; everything ought to have been at once carefully sutured. First operation, June 18, 1901: Incision of the inner canthus, 3 mm. from the edge of the nasal portion on the lower lid and parallel with it, extending as far as where the eyelashes begin, followed by loosening of the lower lid until closure of the palpebral fissure was possible without exerting much friction. From the upper lid, which has an abundance of flaccid skin, a tongue-shaped flap, 3.5 cm. in width and ¾ cm. long, with its base over the inner canthus, was cut and stitched into the defect on the lower lid. The wound on the upper lid was closed with a suture. As the flap was rather long the top became necrotic and sloughed away, so that on July 16th a second operation was performed. By means of an incision along the lower edge of the orbit the lid, which had become everted, was once more elevated, the palpebral fissure again closed with a suture, and the crescentic wound, which was more than 1 cm. in width, covered with skin after the method of Thiersch. Good recovery; discharged August 30, 1901. Closure of the palpebral fissure is good.

Fig. 2.—Condition of the eye fifteen months later: The position of the nasal portion of the lower lid is not quite correct, but the patient is satisfied and refuses to have anything more done.

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suture is passed through the traumatic pterygium after the fold of conjunctiva has been carefully separated from the globe (and, if necessary, also from the conjunctiva) without denuding any more tissue than is absolutely necessary. The two needles are inserted, at a distance of about 3 to 4 mm. from one another, into the transitional portion of the lower lid, brought out through the latter, and the sutures tied over a little roll of cotton. The wound, which is indicated by the dotted line, is then prepared for closure by means of two incisions running parallel to the corneal margin and by undermining the palpebral conjunctiva laterally, and closure effected by means of 2 or 3 horizontal sutures. As the bulbar conjunctiva is extremely movable, it can be utilized for covering a defect in this way without undue stretching.

Fig. 1

Fig. 2

In every case of extensive adhesions between the lids and the globe, whether they be due to injury or to disease, the best practice consists probably in transplanting a thin piece of skin obtained from the inner side of the upper arm, and as nearly as possible free from hair—in other words, a Thiersch flap—for the purpose of covering the wound which is left after carefully separating the lids from the globe. In many cases of this kind, in which the transparency of the cornea has been destroyed by cicatrization, all that is desired is merely to make room for an artificial eye. In view of the numerous and, for the most part, unfavorable experiments with transplantation of mucous membrane (from the mouth, vagina, rabbits, etc.), the transplantation of skin is very much to be preferred. Thin pieces of skin, as nearly as possible free from hair, when transplanted, gradually assume the character of mucous membrane and are well tolerated by the eye. Skin-grafting on the inner surface of the lids is, however, more difficult than on the outer surface, and the operator will succeed better by taking advantage of an observation which is readily made in transplanting a flap of skin after the Thiersch method. It is that the less yielding the soil to which the flap is to be transplanted, the more quickly it will heal and the less will be the secondary shrinking. For that reason large denuded areas immediately overlying bone (as, for example, the large wound in the forehead in the patient shown in Fig. 118) heal very rapidly and without any trouble. In the case of a pedunculated flap the necessary support may be given to it by applying the unyielding surface to the other side—that is to say, to the upper instead of to the lower side of the flap. With this thought in view, Hotz and May greatly improved the method of transplanting skin into the conjunctiva by using a rigid support—Hotz a thin piece of lead and May a suitable glass prothesis—for the flap and maintaining it in a stretched condition.

By loosening a lower lid that is completely adherent to the globe, so that it becomes quite movable and the globe

Plate 25.

FIG. 1.—Complete **symblepharon** and almost complete **ankyloblepharon** in a man forty-two years of age. The condition resulted from a burn of the eye with molten iron. Almost the entire palpebral as well as bulbar conjunctiva was necrotic when the patient was admitted on January 15, 1903, and the cornea was so badly burned that it became perforated on January 23d. On January 28th the globe was enucleated. The picture shows the condition of the orbital region at the beginning of March. On March 13th a new cavity was made for the reception of an artificial eye. On March 19th an attempt was made to close the cavity with flaps of skin, after the method of May; but the result was unsatisfactory, and on March 30th another extensive transplantation was performed. Again the transplanted pieces, for the most part, failed to adhere, and the pieces that did adhere contracted subsequently, so that on April 7th the condition was the same as at the beginning of the trouble.

FIG. 2.—Recent **burn** on the lower portion of the conjunctival sac with a heated piece of iron, in a lad seventeen years of age. The accident happened on December 23, 1902.

Plate 26.

FIGS. 1, 2.—The symblepharon which had meanwhile developed was treated by operation on February 28, 1903 (see text).

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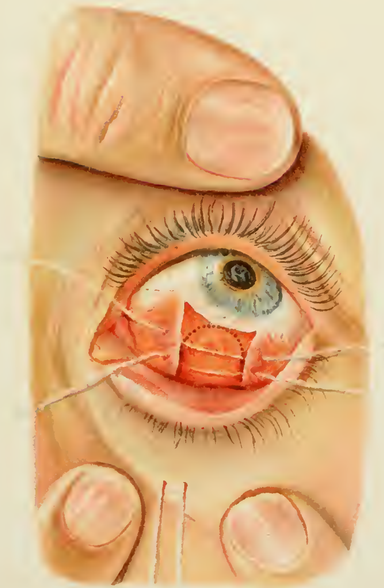
also regains its mobility, and by covering the large wound which occupies the inner aspect of the lid and the lower portion of the globe with flaps after the Thiersch method, the latter may remain in good apposition with the globe and the edge of the lid if the eyes are properly bandaged so as to render the parts absolutely immovable, especially if the flap has been secured to the conjunctiva with a few sutures. In the transitional fold, however, there is nothing to counteract its shortening, and from that point contraction goes on in both directions, and is so marked that the transplanted piece ultimately stretches from the edge of the lid to the globe, and the original condition is restored.

It is possible with this method of skin-grafting to secure the flap in the transitional fold by means of a loop or bridle suture (which von Stellwag used for the transplantation of mucous membrane) and thus keep it in close

Fig. 1

Fig. 2



contact with its support. For that purpose the two needles of a doubly armed suture are introduced through the superimposed flap and through the entire lid, at not too great a distance from one another, and the sutures tied on the outside of the skin, over a small roll of cotton or a piece of drainage tube. Two or three additional sutures may be introduced in the same way alongside the first. These sutures draw the transplanted flap firmly into the transitional fold. That a suture of this kind is useful even in transplantation of mucous membrane is shown by a case of Axenfeld's, in which he succeeded by a plastic operation in restoring the entire conjunctival sac after complete cicatricial symblepharon and ankyloblepharon, although it required four operations, each lasting from two and one-half to three hours. He used mucous membrane from the lips and mouth.

Hotz's lead plate, which can be perfectly adapted to the operative field, offers the great advantage of pressing the transplanted flap evenly over the wound and rendering it immovable. From a piece of lead foil about 0.5 mm. thick (or a piece of tinfoil, as, for example, a piece of a bottle-cap) a suitable piece, usually of a crescentic form, is cut out and bent into the proper shape; a few holes are then bored into the edge that is to fit on the palpebral margin for the sutures with which it is to be secured after the transplanted piece of cutis has been placed in position. The other edge of the lead plate is placed in the transitional fold. The skin itself need not be fixed with sutures. On the other hand it may be well to close the palpebral fissure for a few days with sutures, and to keep an occlusive dressing on the other eye for two days.

May's method was used by Widmark in a number of cases (reported by Landstrom) with good result. After the lids have been separated from the globe and the hemorrhage has been arrested, the glass eye, covered with skin flaps after the Thiersch method, is introduced into the conjunctival sac, the lids are united with sutures, and the dressing applied. The sutures may be removed from the

Plate 27.

Large carcinoma, which has evidently started from the inner canthus of the eye (a small carcinomatous proliferation is also seen on the left side). The patient, who had been referred to the clinic by his physician, has not been able to make up his mind to submit to an operation. The tumor forms a mass 1 to 2 cm. thick and somewhat depressed at the center, where it bleeds readily. By drawing the tumor down the cornea can be seen behind the upper portion. Below, it is adherent to the skin of the cheek, into which it has proliferated.

First operation November 22, 1902: Extirpation of the small tumor on the left side and the large tumor on the right side. The wound, which is the size of a small palus, is seen to be intact and freely movable; the lower lid is altogether deficient; the temporal third of the upper portion was saved and drawn over the cornea as well as possible and united to the temporal portion of the lower lip of the wound and to the palpebral conjunctiva, which had formed a border 0.5 cm. in width, surrounding the cornea toward the nasal side. Four days later we covered the entire wound with skin obtained from the arm after the Thiersch method, with a good result. The remains of the upper lid gradually came down lower and lower over the cornea, which remained entirely intact. Below the cornea was a strip of free palpebral conjunctiva, which on December 15th was reflected upward and covered on its outer side with a flap after the Thiersch method. At the same time the outer canthus was somewhat enlarged by an incision and covered with flaps of skin.

Plate 28.

Shows the patient's condition when he was discharged cured on December 31, 1902. Further attempts to correct and expose the cornea were put off to another time.

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lids after five days, but the glass plate is allowed to remain a few days longer. The method is probably best adapted for eyes with a leukomatous cornea. The procedure, like that of Hotz with a lead plate, may, under certain circumstances, have to be repeated in order to increase the depth of the conjunctival sac. In the case illustrated in Plate 25, Fig. 1, there was complete symblepharon with large ankyloblepharon secondary to an extensive burn of the eye and enucleation of the globe. Two operations after May did not suffice to create enough space for an artificial eye. In this case, however, the difficulties were about as great as could be imagined, and for external reasons the operation unfortunately could not be continued.

When the surgeon is confronted with the task of performing a **blepharoplastic operation** in the narrow sense of the word—that is, forming a complete lid after destruction by malignant disease, injury, gangrene, etc.—the difficulties are multiplied, because both the anterior and the posterior aspects of the lid have to be newly formed.

Such cases, especially when the lower lid is deficient, may be treated by Eversbusch's operation, which is then performed in two sittings. At the first sitting a flap of a suitable size is formed from the neighboring skin (after Fricke). The dorsal side of this flap and the wound produced by its excision are covered with epidermis, the latter covered with protective silk or rubber paper, and the flap returned to its natural position. After the transplanted piece of skin has grown fast, the flap is inserted in place of the lid that has been destroyed, after freshening up the orbital margin as required. Later, Eversbusch recommended that the posterior surface of the flap be covered with mucous membrane obtained from the pharynx of the rabbit.

If the transitional portions of the lower or upper lid are preserved and the other lid is in good condition, the latter may be used for closing the gap after the method suggested by Landolt. For example, if the lower lid is to be restored the intact upper lid is divided into two layers, an anterior layer consisting of cutis and muscle, and a posterior layer consisting of tarsus and conjunctiva. The anterior layer is then converted into a bridged flap by a curved incision along the orbital margin, and this flap is drawn down until the upper edge of the bridge is at the same level as the lower edge of the posterior layer. What remains of the lower lid is split into two layers, and the lower edge of the bridge flap formed from the upper lid is inserted between the two layers and secured with sutures, the bridge flap having first been freshened up on its anterior side also. After the eye has been kept closed for

Plate 29.

The same patient after the **carcinoma had recurred** and had again been removed. On January 26, 1903, he returned with a recurrent growth the size of a hazel-nut at the inner canthus, which, by the time he could be admitted and operated upon (February 3d), had attained the size of a walnut. On that date I did a radical extirpation, covering the wound with a large flap taken from the forehead, with its base at the root of the nose, and, after splitting it at the end, secured it with sutures in such a way as to restore the nasal halves of the upper and lower lids. In order to form a better inferior covering for the cornea I cut a small flap, with its base directed toward the temple, from the surrounding skin and stitched it to the lower portion of the skin flap. The areas from which the large forehead flap and the smaller flap had been taken were covered on February 13th with skin taken from the arm after Thiersch, the wound on the forehead having previously (at the operation) been reduced as much as possible by means of sutures. The picture shows the condition of the eyes in the middle of March. The lower edge of the cornea is not covered, and therefore shows a small marginal ulcer at that point. The patient had to be discharged on March 13th, and further procedures to correct the condition were put off until another time.

Toward the end of March and in April another attempt was made to utilize the small remainder of conjunctiva for small pedunculated flaps to cover the lower portion of the cornea. The attempt was so successful that the patient's discomfort was relieved, and on September 23d he showed visual power of $\frac{1}{24}$ when the upper lid was drawn up or he put his head back. No local recurrence of the tumor has appeared so far, but in September, 1903, a glandular carcinoma had to be removed from the angle of the jaw in the surgical clinic.

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several months a new palpebral fissure is made by incising the membrane.

If the palpebral portions of both lids are absent the remains of the transitional portions are also divided into two layers; but in this case the posterior layer of the lower lid must be freed in its transitional portion by an incision along the orbital margin, so as to make it possible to draw it up. The eye is then covered with a membrane consisting of the 4 layers of the 2 remnants of the lids which have been drawn apart and the edges of which overlap. These 4 layers in alternation present a wound surface first posteriorly and then anteriorly. The latter

would nowadays be covered with flaps after the Thiersch method.

The same method of splitting into layers and interleaving the layers may also be done in a horizontal direction, after Landolt.

Operations on the Conjunctiva.

The most important operations on the conjunctiva that still remain to be considered have to do chiefly with the surgical treatment of trachoma.

As in all other operations on the conjunctiva, the necessity of sparing the membrane as much as possible must be constantly borne in mind.

(1) It is therefore better not to excise the transitional folds unless they are so thickly covered with granules as to leave hardly any normal tissue between them (Galezowski, Heisrath, and others). In such cases from five to eight needles threaded with silk sutures are introduced vertically into that part of the conjunctiva which is to be removed, the area is marked out with a scalpel, and separated from the subjacent tissue with scissors. The sutures are then drawn through and tied.

If the granules are not very thickly scattered over the mucous membrane, it is better to destroy them with the (2) galvanocautery, or to resort to (3) scarification and brushing out with a wire brush like von Schröder's, for example (Fig. 140), or still better (4) crush them out.

The latter method may be combined with scarification, but, as a rule, this is not necessary, because the crushing instruments usually have sufficient force to express the granules from the tissues. To the earliest instruments of this kind, designed by Prince (similar to the forceps shown in Fig. 139) and Noyes, were soon added Knapp's roller forceps (Fig. 136) and Rust's modification of it (Fig. 137). Then appeared Dohnberg's clamp (Fig. 138) and Graddy's instrument, which is in every way similar to it, von Schröder's (Fig. 139) and Kuhnt's expressors with fenestrated end-plates. The longitudinally serrated rolls of

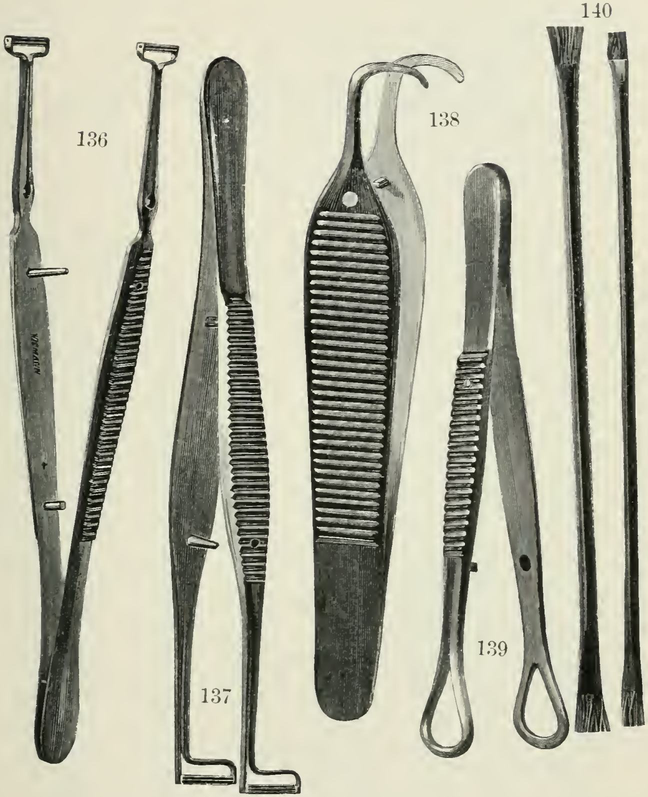
FIGS. 136–140.—Instruments for the treatment of trachoma:
FIG. 136.—Knapp's roller forceps.
FIG. 137.—Rust's roller forceps.
FIG. 138.—Dohnberg's clamp forceps.
FIG. 139.—von Schröder's clamp forceps.
FIG. 140.—von Schröder's wire brush.

Knapp's forceps and Rust's modification—the latter enables one to get a better hold of the most lateral portions of the transitional folds—must be kept in perfect condition and guarded against rust, because it is important that the rollers should rotate properly; hence they should be cleansed immediately after being used.

After the eye has been thoroughly anesthetized by means of cocain and adrenalin, the roller and clamp forceps are applied to the everted lids. [Guttinan recommends a form of subconjunctival infiltration anesthesia with a cocain and salt solution.—ED.] The transitional fold of the upper lid is seized with the fixation-forceps and drawn away from the eye, so that the entire lid may be seized, between the ends of the instrument. On the lower lid the fixation-forceps can be dispensed with. The affected portion of the tissue is manipulated by drawing it out with the instrument until it is free from granules. The angles of the lid and, if necessary, the caruncle must be carefully attended to. If the tarsal conjunctiva contains granules, one blade of the roller forceps is applied to the skin of the lid and the other to the conjunctiva, and the instrument passed over the lid several times in this way until all the granules have disappeared.

In all these expressing operations it is a wise precaution to wear protective spectacles, so as to guard against any of the infectious material entering the eyes. I have heard that in Russia physicians have become infected while performing this operation.

No bandage is required after the operation, and the patient, as a rule, feels very much relieved. [Immediately after an operation for expression, with forceps, of trachoma granules, iced compresses are of service. The subsequent



treatment with a bichlorid (1 : 7000) lotion and argyrol or protargol, to lessen discharge, is important.—Ed.]

D. OPERATIONS ON THE LACRIMAL ORGANS.

In the great majority of cases operative interference is required to correct abnormalities in the flow of the tears into the nose, usually as a result of narrowing of the nasal duct and its consequences.

FIGS. 141–148.—Instruments for operations on the lacrimal passages:
FIG. 141.—Retractor after L. Müller.
FIG. 142.—Glass syringe with cannula.
FIG. 143.—Blunt (conical) probe for dilating the canaliculus.
FIG. 144.—Weber's knife for splitting the canaliculus, curved.
FIG. 145.—Same instrument, straight.
FIG. 146.—Bowman's sound, before it has been bent for use.
FIG. 147.—Bowman's sound, after it has been bent for use.
FIG. 148.—Von Wecker's hollow sound.

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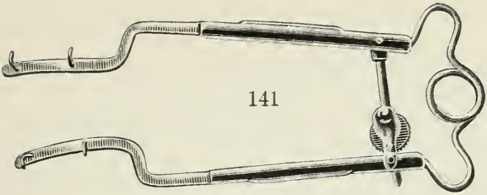
1. **Simple eversion of the lower lacrimal punctum** when the lacrimal passages are otherwise normal may, however, cause lacrimation and prove the beginning of an ectropion. If the lower punctum is not below the level of the tear-lake, the accumulated lacrimal fluid is very apt to run over, and the patient keeps wiping his eye, which he does, as a rule, in an outward and downward direction. The lower lid is thus dragged downward and outward, and if the tissues are flaccid from old age this may lead to the production of ectropion, assisted as it is by the shortening of the skin, which is caused by the excessive maceration and excoriation. A vicious circle is thus established, by which a simple eversion of the lower lacrimal punctum may lead to ectropion.

For this reason the anomaly, which, as a rule, is the result of the relaxation of the lid, ought to be removed as soon as possible, first, by ordering the patient always to wipe his eye in an inward and upward direction; secondly, by splitting the lower canaliculus. The splitting must be done in such a way that the slit is submerged in the tear-lake, and, hence, the posterior, and not the upper, wall of the canaliculus must be divided. After the lower canaliculus has been somewhat dilated with a conical probe (Fig. 143) in a manner to be described presently (Figs. 149, 150), one of the blades of a slender, blunt pair of scissors is inserted into the canaliculus, which is at the same time drawn well away from the globe. The edge of the scissors blade is then turned toward the posterior wall of the canaliculus, so that the other blade comes close against



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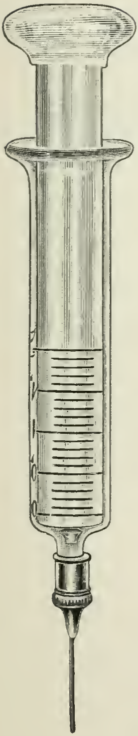

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the globe, and the canal divided. After the lid has been allowed to resume its normal position, the slit should be directed downward toward the lower portion of the caruncle.

This, however, is not enough; for the wound would simply grow together again. In order to keep it open it must be dilated several times with a probe during the next few days, or, what is still better, Hoffmann's suggestion of cutting off one edge of the slit with the scissors and thus converting the canal into a groove may be adopted after the canaliculus has been opened.

2. With regard to **dacryostenosis,** which is such a common trouble, I am convinced, after years of experience, that operative treatment, which includes dilatation with the probe, should not be resorted to until the more conservative treatment by the injection of medicated solutions and the treatment of the nasal cavity, if the latter is also diseased, have failed to effect a cure. I am therefore firmly opposed to the employment of the sound from the very beginning as a matter of routine (see my *Atlas and Epitome of External Diseases of the Eye*, p. 89).

Irrigation of the lacrimonasal duct, which has already been discussed as a preliminary measure in major operations (p. 57), is performed with a syringe armed with a delicate cannula. A glass syringe (Fig. 142) is the best. In order that the cannula may be readily introduced into the lower canaliculus, the latter is cautiously dilated with a blunt probe (Fig. 143). In the case of sensitive persons a few crystals of pure cocain should be applied to the lacrimal punctum a little while before the operation is begun. The probe must be introduced in a direction corresponding to that of the canaliculus—that is, at first vertically (Fig. 149) for a distance of from 1 to 2 mm., and then brought into the horizontal plane (Fig. 150) and cautiously advanced with a slight boring movement. The syringe, which has been previously filled with the fluid, is then at once introduced, also at first in a vertical direction, and the contents gradually discharged into the lacri-

mal sac by pushing on the piston (Fig. 151). The patient should incline the head slightly forward to allow the fluid to run out through the nose.

Even this simple procedure is not always quite easy, and an inexperienced operator is likely to make a false passage with the conical probe or with the cannula—that is, push it into the tissue, which, if bichlorid of mercury is used, is followed by a severe and painful swelling of

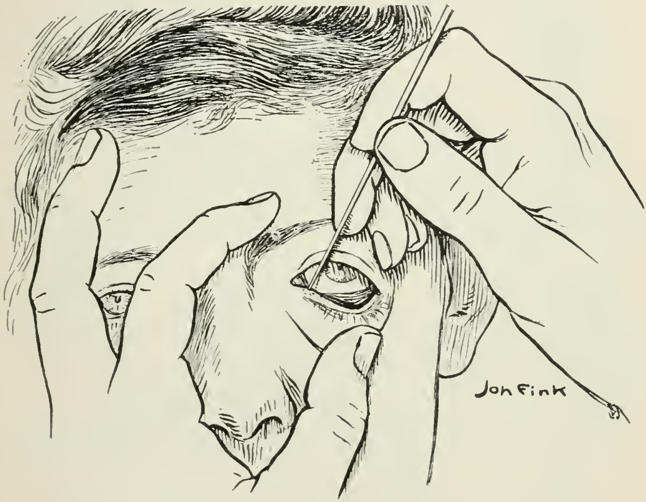

FIG. 149.—Dilation of the lower lacrimal canaliculus: First step.

the tissue surrounding the canaliculus, lasting several days.

For this reason, if the operator is not quite sure of himself he should use a physiologic saline solution when he performs his first irrigation. Medicated solutions that may be recommended are bichlorid of mercury, 1 : 5000 up to 1 : 1000; protargol, 5 to 10 per cent.; [argyrol, 10 to 25 per cent.—ED.]; silver nitrate or zinc, 1 per cent., etc. An important precaution consists in injecting the

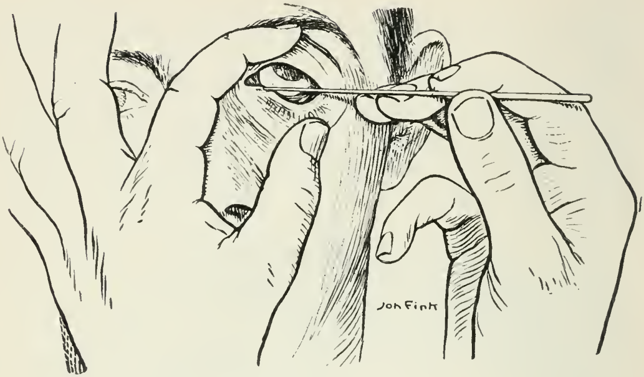

FIG. 150.—Dilation of the lower lacrimal canaliculus: Second step.

canal with adrenalin, which causes some dilation and thus affords an easier passage not only for the medicated solutions,

FIG. 151.—Injecting the nasal duct.

but also for the probe. In the case of sensitive persons it is best to begin by injecting a few drops of cocain solution, as the medicated solutions are then less unpleasant.

3. **Dilation of the nasal duct by means of sounds** should be left to the practiced specialist, for it is a useless procedure unless the technic is perfect and due

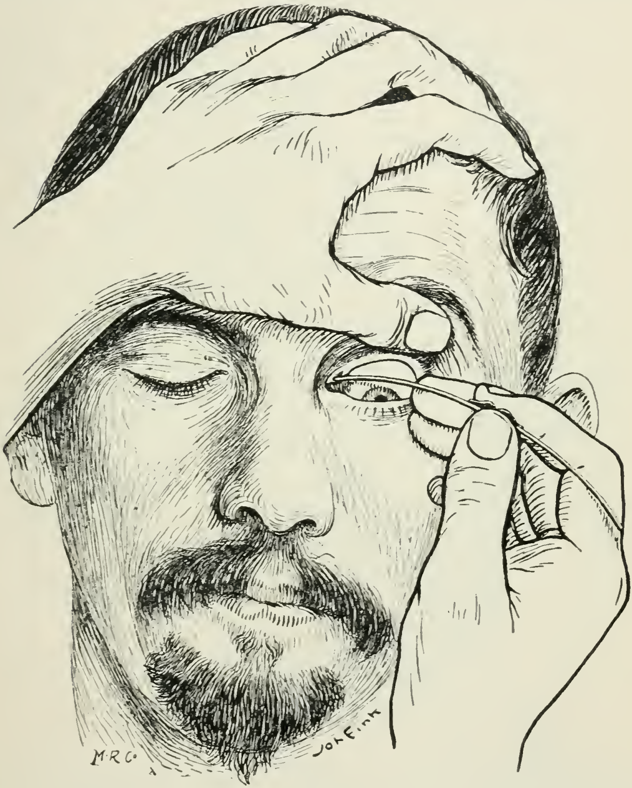

FIG. 152.—Dilation of the nasal duct with the sound: Introduction of the sound into the tear sac.

caution is observed. It is better to use the upper canaliculus, because the introduction of the sound causes less distortion than in the lower canaliculus. A day before the sound is introduced the canaliculus is to be split with

a bent or straight Weber's knife, if necessary, after preliminary cocainization and dilation with the conical probe. The sound selected for the dilation should not be too

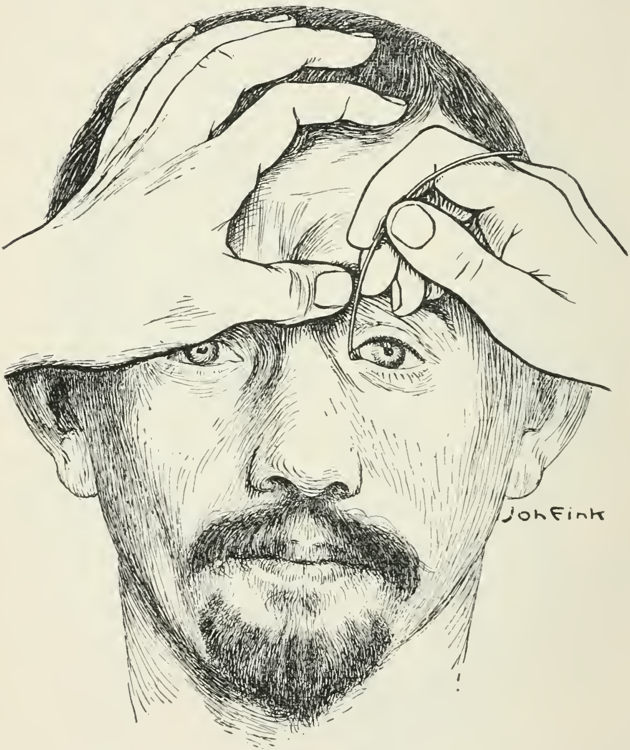

FIG. 153.—Dilation of the nasal duct with the sound: Introduction of the sound into the lacrimonasal duct.

small; Bowman's No. 3 or 4 (Fig. 147) is the best. Before the sound is introduced a few drops of a 2 to 5 per cent. solution of cocain, followed by adrenalin, or the two together are injected into the duct, and if the latter is

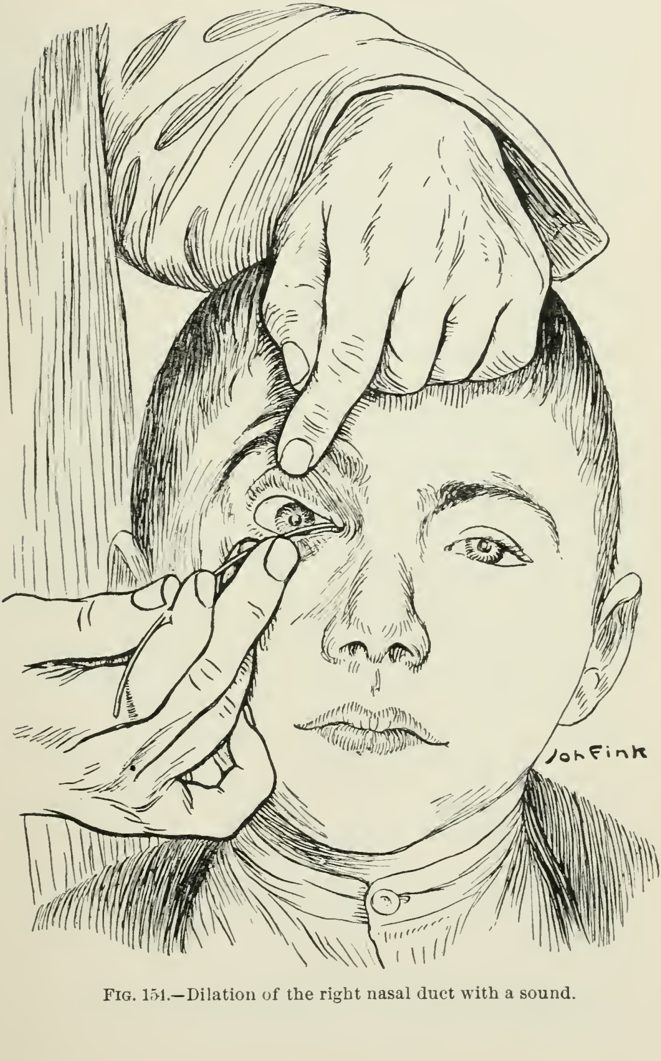

FIG. 151.—Dilation of the right nasal duct with a sound.

Plate 30.

FIG. 1.—Extirpation of the tear sac in a woman, thirty-three years of age, who states that the left eye began to run six months previously. Swelling (ectasia) of the tear sac and suppuration began four months previously. The patient would not hear of extirpation of the tear sac, which was proposed, and had herself treated elsewhere for three months by sounding. She also said an incision and curettage had been performed. As, however, the purulent catarrh of the tear sac persisted, she returned to the clinic on October 28, 1902, and was relieved of her tear sac under local anesthesia with a eucain-cocain solution. Normal recovery.

Plate 30.

FIG. 2.—The extirpated tear sac, which had probably not been reached by the incision and curettage referred to.

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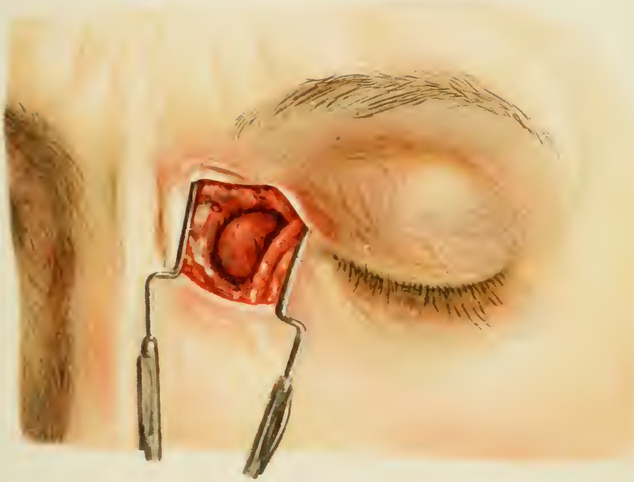
still permeable, so that the solution flows out through the nose, this procedure will materially facilitate the introduction of the sound and make the operation much more bearable to the patient.

As the sound is introduced into the canaliculus and tear sac the upper lid must be drawn well outward—that is, the canaliculus must be straightened and put on the stretch (Fig. 152). The sound must not be brought into the vertical position until the point has evidently touched the bony nasal wall of the tear duct. As the sound passes into the lachrimonasal duct (Fig. 153), special caution should be used and the instrument should be advanced very slowly, because it is at this junction that strictures are quite often found. During this step the skin above the tear sac should be drawn well upward with the thumb of the left hand, while the rest of the hand is used to steady the patient's head. In sounding the right canaliculus the operator should stand behind the patient (Fig. 154).

After the sound has successfully reached the nasal duct, it is very cautiously introduced along the passage, and withdrawn from time to time for the purpose of smoothing out any folds of mucous membrane. It is utterly wrong to employ force when it is found impossible to introduce it any further. Instead it should be allowed to remain in



place about half an hour and then removed, and another attempt made after two or three days to push it further along, which attempt quite often proves successful. At the second sitting, also, the sound should not be carried farther than it will go with gentle pressure. If the operator gets the impression that the sound is completely through the canal (so that the leaf stands at the inner extremity of the eyebrow), he should make sure of the fact by injecting some fluid. The sound is carefully withdrawn after half an hour, the patient's head being firmly fixed with the left hand during the process, and von Wecker's hollow sound (Fig. 148) is introduced into the canal in the same way as the solid sound. The wire is then withdrawn and fluid injected with a glass syringe. By slowly withdrawing the hollow sound the entire canal and tear sac may be flushed out with the medicated solution. The introduction of the sound should always be followed by an irrigation of this kind.

4. **Extirpation of the tear sac** in cases of impermeable stricture that lead to the accumulations of secretions in the sac and irritation of the eye with danger of purulent keratitis is an excellent operation, which, as a rule, is followed by very good results and leaves a very slight scar. It is much to be preferred to obliteration of the sac with caustics, which was formerly in vogue. An incision having been made from the front, after Petit, or from the side by splitting both canaliculi, the slits were deepened until they extended into the sac. It is also preferable to curettage and cauterization by means of Petit's incision. This ancient operation was again recommended, especially by Berlin, and has gradually won general acceptance.

As a preparatory measure it is well, if possible, to flush out the sac with protargol for several days, so as to cleanse it at least partially. The operation, unless dense adhesions of the sac from former inflammatory conditions and forcibe sounding are suspected, may be performed under local anesthesia with eucain-cocain-adrenalin. If the adrenalin

is added, the hemorrhage, which is so troublesome in this operation, is usually quite inconsiderable, and the operation, therefore, much less difficult. In general anesthesia, especially with ether, the hemorrhage may be very severe and very troublesome, particularly in obese persons. From time to time the wound must be sponged with cocain-adrenalin and the operation interrupted to wait for the drug to act. In rather anemic and emaciated individuals the operation may be quite a simple one, particularly if the sac is somewhat dilated and the walls are thick. Under local anesthesia the above-mentioned solution is injected not only into the sac itself, but also subcutaneously, and to some depth into the tissues surrounding the sac. Ten minutes should be allowed to elapse before beginning the operation, when it may be performed, if not quite painlessly, at least without giving the patient very much discomfort.

As the wound is very deep, it is indispensable to have a good light; if necessary an electric light reflected from a head mirror. For the same reason it is better to make the skin wound large—that is, from 2 to 3 mm. in length—so as to gain free access to the operative field. As the scar is usually invisible, 1 cm., more or less, is of no importance. The incision is carried in a curved direction around the inner canthus over the nasal extremity of the palpebral ligament, so that $\frac{1}{3}$ of it lies above and the other $\frac{2}{3}$ of it below the said ligament. It is best to carry the initial incision as far as the palpebral ligament, which is divided near its insertion in the bone. The nasal wall of the sac is then dissected away along the ligament, after which the upper dome is separated with the scissors and blunt dissector. The temporal wall of the sac is then exposed, the operator taking great care not to go too near the globe nor to injure the internal rectus. I once saw an operation for extirpation of the lacrimal sac (not performed by me), in which the muscle was probably partly excised, complete loss of function of the internal rectus, and, although I made two attempts, I was unable to correct the

condition. It is therefore important to keep the wound in constant view either by means of hooks or Müller's retractor (Fig. 141) and Axenfeld's, which holds the wound apart from below upward also. In addition it is indispensable to keep the operative field clean by constant sponging; in some cases it may be necessary to ligate the artery. After the sac has thus been exposed (Plate 30), it is fixed with a heavy pair of forceps, freed on its posterior surface, and finally divided at its lower extremity where it merges into the lacrimonasal duct.

When it is impossible to dissect out the sac in this way as a whole, the operation must be completed with a sharp knife, as no part of the mucous membrane must be left behind. In doing so the upper portion of the lacrimonasal duct may also be curetted away, but the curet should not be carried too far down, as the blood may flow into the nose, pharynx, and larynx.

After the wound cavity has been well flushed out with 1 : 1000 bichlorid solution and wiped out with sponges, it may be dusted with a little iodoform powder; although this is not necessary. The skin wound is then closed with a few deep and several superficial sutures, iodoform gauze is applied, and the eye bandaged with gentle pressure. Convalescence is usually remarkably good, and in from six to seven days the sutures can be removed and the wound can be painted with iodoform collodium. Many operators prefer to split the sac before turning it out, and then to dissect it out. It is possible that this procedure may render it easier to find the sac, which is often difficult in the deep bloody wound. By taking one's bearings by the palpebral ligament, and, if necessary, by filling the sac with fluid during the operation through one of the canaliculi, it is hardly possible to miss it.

The filling the sac with paraffin is a good operation when it is successful; but its performance, as I have satisfied myself, is not very easy. In suitable cases it may be effected by means of von Pflugk's syringe and heating-iron, which can be obtained from Windler, in Berlin.

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